

Penguin monitoring and conservation activities in the Gulf St Vincent

July 2018 – May 2019



Report to the Adelaide and Mt Lofty Ranges Natural Resources Management Board
Dr Diane Colombelli-Négrel
April 2019

College of Sciences and Engineering
Flinders University, GPO Box 2100,
Adelaide 5001, Australia

Table of contents

I. SUMMARY.....	3
II. INTRODUCTION.....	4
III. AIMS.....	4
IV. MATERIALS AND METHODS	5
Study sites	5
Granite Island nightly counts	6
Population Census.....	6
Additional data.....	7
<i>Habitat preference of little penguins</i>	7
<i>Time budgets and thermoregulation</i>	7
<i>Environmental conditions and breeding success</i>	8
<i>Behavioural and heart rate responses to stressors</i>	8
Ethics.....	8
V. RESULTS	9
Breeding monitoring	9
Granite Island nightly counts	10
Disturbance	10
Population Census.....	14
<i>Granite Island</i>	14
<i>Troubridge Island</i>	15
<i>Wardang Island</i>	15
<i>Goose Island</i>	15
<i>Spilsby Island</i>	16
<i>Hareby Island</i>	16
<i>Smith Island</i>	16
<i>English Island</i>	16
<i>Rabbit Island</i>	16
<i>Louth Island</i>	16
Additional data.....	17
<i>Habitat preference of little penguins</i>	17
<i>Time budgets and thermoregulation</i>	17
<i>Environmental conditions and breeding success</i>	18
<i>Behavioural and heart rate responses to stressors</i>	18
VI. DISCUSSION.....	18
VII. DIRECTIONS FOR FUTURE RESEARCH	21
VIII. MANAGEMENT RECOMMENDATIONS	21
IX. COMMUNITY ENGAGEMENT	23
X. ACKNOWLEDGEMENTS	23
XI. REFERENCES	24

I. SUMMARY

This project further investigated little penguin (*Eudyptula minor*) population trends in South Australia. Granite and Troubridge Island populations showed stable trends: population on Troubridge Island was 496 penguins present at the time of the census, and population on Granite Island was 44 penguins at the time of the census.

Granite Island continued to have a high breeding success (2.00 ± 0.36 fledgling per pair) with 25 fledglings produced in the 2018-breeding season. However, previous study showed that survival rate of little penguins after fledgling was extremely low (2%) suggesting that only 0-1 of those 25 fledglings is expected to survive until breeding maturity, and more than 200 fledglings per year need to be produced to increase population size by 10%.

Nightly counts occurred on 253 nights and showed that human and dog disturbances on Granite Island significantly increased from < 2% to 23%, which is of concern. Presence of rats also increased from 2% to 16% of the monitored nights, and rat control need to be re-addressed. Regular events and concerts late at night as well as uncontrolled construction works on the island add additional stress to this population. While numbers are low, the Granite Island little penguins attract 5000+ visitors per year, which represents an economic value of at least \$115000 each year. Therefore, urgent measures - such as (a) prohibiting access to the public at night (unless on an authorised tour), (b) improving signage and (c) changing regulations - need to be taken to decrease disturbance from human activities and ensure the long-term survival of this population. It is also suggested to create a Granite Island working group to improve communication between all parties involved.

This project also presents updated results of population surveys on Wardang (estimated at 279 adults), Goose (estimated at 38 adults), Spilsby (estimated at 410 adults), Hareby (estimated at 60 adults), English (no penguin present), Rabbit (estimated at 8 adults), Louth (estimated at 50 adults), and Smith Islands (no penguin present). The results of these surveys stress the importance of ongoing monitoring for coordinated state wide assessments.

II. INTRODUCTION

The little penguin (*Eudyptula minor*) is a small flightless seabird found in New Zealand and throughout the southern coast of Australia (Marchant & Higgins 1990, Peucker et al. 2009). It is considered a common species, with a total of 300-500,000 breeding individuals in Australia (Maher 2014). South Australia is believed to host approx. 100 little penguin colonies; however, in the last decades, 20+ colonies are suspected to have declined for reasons not well understood (reviewed in Wiebkin, 2011; DEWNR 2016). This study is an ongoing project, funded by the Adelaide and Mount Lofty Ranges Natural Resources Management Board, to monitor penguin populations in Gulf St Vincent (South Australia) and implement conservation actions identified by Wiebkin (2011).

Previous reports showed that (1) Granite Island had the highest breeding success overall, and that population decline on this island stabilized to approx. 20-30 adults since 2012 (Colombelli-Négrel 2018). (2) Other studies suggested that native water-rats (*Hydromys chrysogaster*) and introduced black rats (*Rattus rattus*) were potential predators on Granite Island (Bool et al. 2007). Both motion-camera monitoring and post-mortem analyses failed to provide any evidence of nest predation on this island since 2012 (Colombelli-Négrel and Tomo 2017), likely due to the intense rat-baiting that occurred since 2006. (3) However, human disturbance on Granite Island had increased by six-fold since 2016 raising some concerns for the long-term survival of the population (Colombelli-Négrel 2018). (4) On Kangaroo Island, ~30% of the burrows showed signs of predation, mostly by goannas (*Varanus rosenbergi*) and cats (*Felis catus*) on older chicks (Colombelli-Négrel 2015a, b; Colombelli-Négrel and Tomo 2017). (5) Population censuses on Kangaroo Island showed declining trends for Emu Bay, Antechamber Bay and Kingscote (Colombelli-Négrel 2015a, 2016a, 2017). (6) The Troubridge Island population seem to show a stable trend since 2013, with 450 penguins present at the time of the census in 2017 (Colombelli-Négrel 2018). Little penguins breeding on Troubridge Island differed in genetic structure, morphology and vocalisations compared to the other colonies in the Gulf St Vincent (Colombelli-Négrel 2015a, 2016b, Colombelli-Négrel and Smale 2018). (7) Althorpe Island showed a constant declining trend since 2013, with only 18 adults in 2017 (Colombelli-Négrel 2016a, 2017, 2018). (8) Blood parasites (*Haemoproteus* and *Plasmodium* spp.) were identified in 86% of the individuals sampled across all colonies (Colombelli-Négrel 2016a). (9) The presence of little penguin remains in long nosed fur seal (*Arctocephalus forsteri*) diet varied from 40% in the Fleurieu Peninsula to 10% in the Yorke Peninsula and 4% on Kangaroo Island, suggesting that penguin presence within the regions may not be the main driver for predation rates (Colombelli-Négrel 2015a). (10) Finally, the timing of breeding and moulting varied across colonies and years, and breeding success was strongly influenced by nest type as well as the local environmental conditions (Colombelli-Négrel 2018).

III. AIMS

The following report outlines the data collected between July 2018 and May 2019. The current project has the following objectives: (1) to continue breeding monitoring on Granite Island; (2) to conduct population surveys on Troubridge and Granite Islands; (3) to organise community events to educate the public about the penguins' situation; and (4) to continue the citizen science approach to collect regular nightly penguin count and disturbance data on Granite Island.

This report also (a) presents the results of population surveys on Wardang, Goose, Spilsby, Hareby, English, Rabbit, Louth, and Smith Islands, (b) provides information on habitat factors that might influence distribution of little penguins in South Australia, (c) presents information on adult and chick time budgets and thermoregulation, (d) investigates factors that influence breeding success in little penguins at a larger scale than previous report, and (e) investigates how little penguins varied in their behavioural and physiological responses to different stressors (cat, dog, human and conspecific).

IV. MATERIALS AND METHODS

Study sites

This project was conducted between August 2018 and March 2019 on two islands in the Gulf St Vincent: (1) Granite Island ($35^{\circ}37'S$, $138^{\circ}36'E$) in the Fleurieu Peninsula, and (2) Troubridge Island ($35^{\circ}06'S$, $137^{\circ}49'E$), in the Yorke Peninsula. Additional data are also presented for (1) Wardang Island ($34^{\circ}28'S$, $137^{\circ}18'E$, Yorke Peninsula), (2) Goose Island ($34^{\circ}27'S$, $137^{\circ}21'E$, Yorke Peninsula), (3) Spilsby Island ($34^{\circ}39'S$, $136^{\circ}20'E$; Spencer Gulf), (2) Hareby Island ($34^{\circ}34'S$, $136^{\circ}17'E$; Spencer Gulf), (3) English Island ($34^{\circ}38'S$, $136^{\circ}11'E$; Spencer Gulf), (4) Rabbit Island ($34^{\circ}36'S$, $135^{\circ}59'E$; Spencer Gulf), (5) Louth Island ($34^{\circ}34'S$, $135^{\circ}57'E$; Spencer Gulf), (6) Smith Island ($34^{\circ}58'S$, $136^{\circ}01'E$; Spencer Gulf). The study sites are presented in Figure 1.

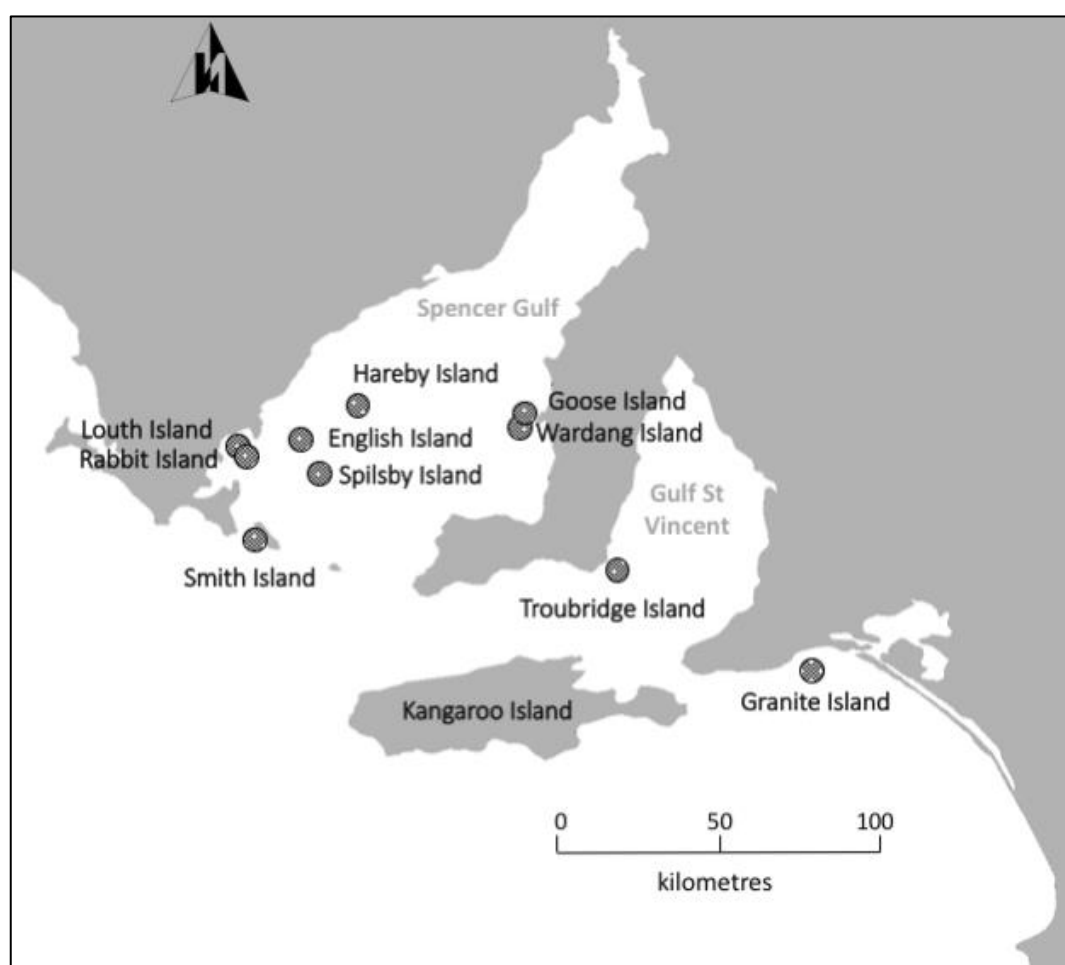


Figure 1. Distribution of the little penguin colonies surveyed in 2018.

Breeding monitoring

Searches for active nests on Granite Island started around June and were carried out until March. A nest was recorded as active if it contained either eggs, chicks or adults or had clear evidence of penguin presence, such as fresh droppings or a strong penguin smell. Once found active, nests were checked every 2 weeks. To assess breeding success, the number of eggs, chicks and adults present in each nest was recorded during each visit. A chick was considered as fledged when it disappeared from the nest at about eight weeks of age and was not found in any of the other nests. Breeding success was defined as the number of chicks that fledged per breeding pair.

Granite Island nightly counts

The nightly penguin counts report on the number of penguins counted by the Penguin Tour Guides on the north shore during the Little Penguin Tours. Tours are conducted for visitors to spot little penguins as they return from the ocean at sunset and last approximately 1 to 1.5 hours. Tours are run on a regular basis all year round and are currently managed by Oceanic Victor. Additional nightly counts are conducted by Flinders University research team following the same guidelines in weeks when no Little Penguin Tours are scheduled. In 2018, 5000+ visitors joined a Little Penguin Tour on Granite Island, which represents an economic value of a minimum of \$115000 per year.

Disturbances, such as people walking or driving unauthorised on the island at night, people using light torches, flashes or walking their dogs were also recorded by the Tour Guides and research team.

Population Census

Population size for each colony was estimated either by surveying the entire colony or, in the case of large islands, by using transects or 30 x 30 m quadrats in areas where little penguins were present. Such areas were determined using a combination of (1) random searches, (2) local knowledge from park rangers (and local habitants for habited islands), (3) knowledge from previous surveys and (4) helicopter surveys (when possible) to determine potential penguin habitat within an island.

Granite Island, English Island and Goose Island were surveyed entirely. Troubridge Island was surveyed using six 30x30m quadrats that were selected to reflect varying habitats (open, closed) and penguin densities (low, high). Data extrapolated from the quadrat surveys on Troubridge Island are comparable to the surveys conducted over the entire island (Colombelli-Négrel 2017a, 2018). All the other colonies were surveyed using transects positioned along the coast, and total population size was extrapolated based on the availability of penguin habitat. Nests were searched within ~1 m on the land side of the transect line and all the way to the water line on the water side. The number and length of transects varied between colonies due to the size and shape of the islands and the vegetation present (2-9 transects per colony, 400m-1km long).

Censuses were conducted either in May (Wardang and Goose Islands), August (Spilsby, Hareby, English, Rabbit, Louth, Smith Islands) or in late September/October (Granite and Troubridge Islands). August and late September/October corresponded to the peak of breeding for the respective selected colonies. Since 2016, several surveys have been conducted on Wardang Island at different time of the year (May/June vs September/October) to assess variation in penguin density in relation to the time of the census; counts of active nests were comparable across years and months (Colombelli-Négrel 2017a, 2018). This report presents all the data collected on Wardang Island since 2016. This report also presents the results of an additional survey on Goose Island conducted in June 2017 by local rangers. Censuses on Wardang, Goose, Spilsby, Hareby, English, Rabbit, Louth and Smith Islands

were funded by the Nature Foundation SA, Birds SA, Australian Geographic, Alongside Wildlife Foundation and Flinders University.

Additional data

Habitat preference of little penguins

This study examined which habitat variables best predict the spatial distribution and presence/absence of little penguins in South Australia. This question was investigated at the meso (distribution between colonies), topo (nest site density within colony), and micro scale (characteristics of the individual nest). Data were collected between 2016 and 2018 as part of Larissa Iasiello's Honours project (2018-2019) entitled '*Investigation of breeding habitat preference in little penguins (Eudyptula minor) across several South Australian offshore islands*' under the supervision of Dr Diane Colombelli-Négrel. This project was funded by the Nature Foundation SA, Birds SA, Australian Geographic, Alongside Wildlife Foundation and Flinders University.

At the meso scale, the following habitat characteristics were recorded for each island: (1) the distance to the nearest active penguin colony (km), (2) island size (ha), (3) maximum height above sea-level (m), (4) total number of landing sites, and (5) maximum water depths (m). Data for (1-4) were collected using Google Earth 7.1 (<http://earth.google.com>); data for (5) were retrieved from GPS Nautical Charts (<http://www.gpsnauticalcharts.com/main/>) using a radius of 20 km around each colony.

At the topo scale, local habitat was surveyed within two 30 x 30 m quadrats: one quadrat in an area where no penguin was found (or in the case of colonies where penguins were found everywhere, in an area of low little penguin nest density (less than three active nests)), and one quadrat in an area where penguins were present (for colonies with low number of active nests overall) or in areas of high little penguin nesting density (on average six nests per quadrat). Within each quadrat, the following was recorded: (1) the dominant shrub and ground plant species, (2) the percentage of vegetation cover within the quadrat, the presence or absence of (3) weed plant species, (4) predator species, (5) competitor species, and (6) the slope (measured using a C I Slope Meter, Haglöf, Sweden).

At the micro scale, the following nest site characteristics were noted for as many nests as possible: (1) activity (active vs inactive), (2) nest type (surface, sand, bush, rock, or artificial nest; see Colombelli-Négrel 2019), (3) percentage of vegetation above the nest estimated visually when standing 1 m away, (4) main plant species above the nest, and (5) nest entrance orientation.

Time budgets and thermoregulation

This study investigated the time budgets of adult and chick little penguins and their thermoregulation behaviours in relation to nest microclimate (temperature and humidity) and vegetation cover. Data were collected in 2016 and 2017 and analysed as part of Riley Genders's Honours project (2018) entitled '*Investigating time budget differences in adult and chick little penguins (Eudyptula minor) in relation to nest microclimate and vegetation cover*' under the supervision of Dr Diane Colombelli-Négrel. This project was funded by the Nature Conservation Society of South Australia, Birds SA and Flinders University.

A total of 60 nests (23 nests with chicks and 37 nests with incubating adults) were video monitored. For each nest, the percentage of vegetation above the nest was visually estimated following Colombelli-Négrel (2019). Data on nest temperature and humidity were collected via iButton thermal sensors (Thermochron iButton model DS1923-F5#1 Maxim Integrate Products Inc.) placed inside the nests for the duration of filming. The average time spent in the following behaviours was noted: (1) sitting; (2) crouching; (3) standing; (4) dozing; (5) resting; (6) vigilance; (7) maintenance and (8) gular

fluttering. Additionally, the response of adults and chicks to a sudden and short increase in experimental heat was observed.

Environmental conditions and breeding success

The impact of environmental conditions on little penguin breeding success across ten colonies was investigated as part of Bianca Jonhson's Honours project (2018) entitled '*Poorer breeding success in South Australian little penguins is correlated with low rainfall and high wind speeds.*' under the supervision of Dr Diane Colombelli-Négrel. This project was funded by the Adelaide and Mt Lofty Natural Resources Management Board, the Nature Conservation Society of South Australia, Birds SA, the Field Naturalists Society of South Australia, the Nature Conservation Society of South Australia, and the Lirabenda Endowment Research Fund.

The project focused on ten colonies across four islands within South Australia (Granite Island, West Island, Troubridge Island, Kingscote, Emu Bay, Brownlow, Nepean Pines, Penneshaw, Antechamber Bay and Vivonne Bay). Breeding data were collected as previously described between 1990 and 2016. Environmental data (sea surface temperature, maximum air temperature, wind speed, chlorophyll-*a* concentrations and rainfall) for the 3-months prior and during the breeding season were collected from the Bureau of Meteorology, the Integrated Marine Observing System (IMOS) <http://imos.org.au/home.html> and MODIS (moderate resolution imaging spectroradiometer) (see method in Auricht et al. 2018).

Behavioural and heart rate responses to stressors

This study investigated how little penguins in South Australia varied in their behavioural and physiological (heart rate) responses to different stressors. Data were collected in 2017 and 2018 as part of Anna Hayes' third-year project (2018) entitled '*Little penguins' behavioural and physiological response to stressors from penguin, feline, canine and human playback*' under the supervision of Dr Diane Colombelli-Négrel. This project was funded by Flinders University, Birds SA and the Nature Foundation.

A total of 34 adult little penguins were resented with playback of dog barks, cat calls, penguin calls, human voices or white noises during the incubation period. Each playback was conducted as described in Colombelli-Négrel (2017).

Ethics

This project was approved by the Flinders University Animal Welfare Ethics Committee (No. E449) and was supported by scientific permits to conduct the research (Y26040, A24684-19). Progress report on the numbers of animals that were used will be provided to DEW on 30/6/2019.

V. RESULTS

Breeding monitoring

Between August and March, a total of 10 nests were monitored on Granite Island (Table 1). Out of the 10 monitored nests, eight showed signs of breeding activity (80%) such as eggs or chicks present in the nest. From these eight nests, a total of 18 eggs and 15 chicks were produced; therefore 83% of eggs hatched successfully. A total of 15 chicks fledged from these eight monitored nests, and an additional seven chicks from five unmonitored nests were seen fledged during the night tours. Total breeding success was 2.00 (± 0.36) fledglings per pair (Table 2; Figure 1).

Total Nest Monitored	No. Breeding Nests	No. Eggs	No. Chicks	No. Fledglings	Groups with 2 nd clutch
10	8	18	15	15	3

Table 1. Number of eggs, chicks and fledglings monitored on Granite Island in 2018.

2018 Eggs/ Pair (SE)	2018 Breeding success (SE)	2017 Eggs/ Pair (SE)	2017 Breeding success (SE)
2.27 (± 0.27)	2.00 (± 0.36)	2.25 (± 0.13)	1.87 (± 0.27)

Table 2. Breeding success and number of eggs per pair (mean \pm standard error) observed on Granite Island for 2018 and 2017.

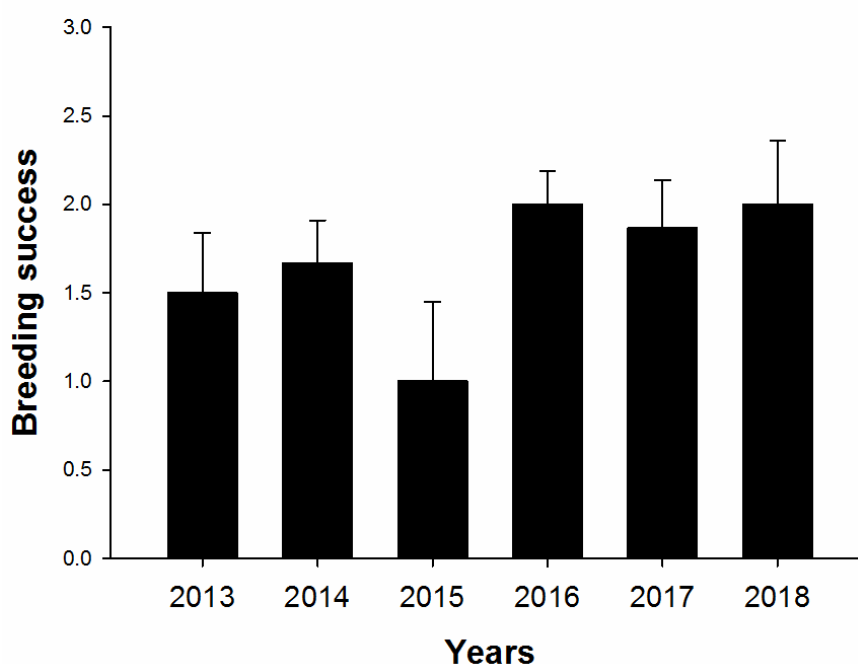


Figure 1. Breeding success across on Granite Island between 2013 and 2018

Granite Island nightly counts

The daily attendance of little penguins during the North Shore night tours is presented in Figure 2.

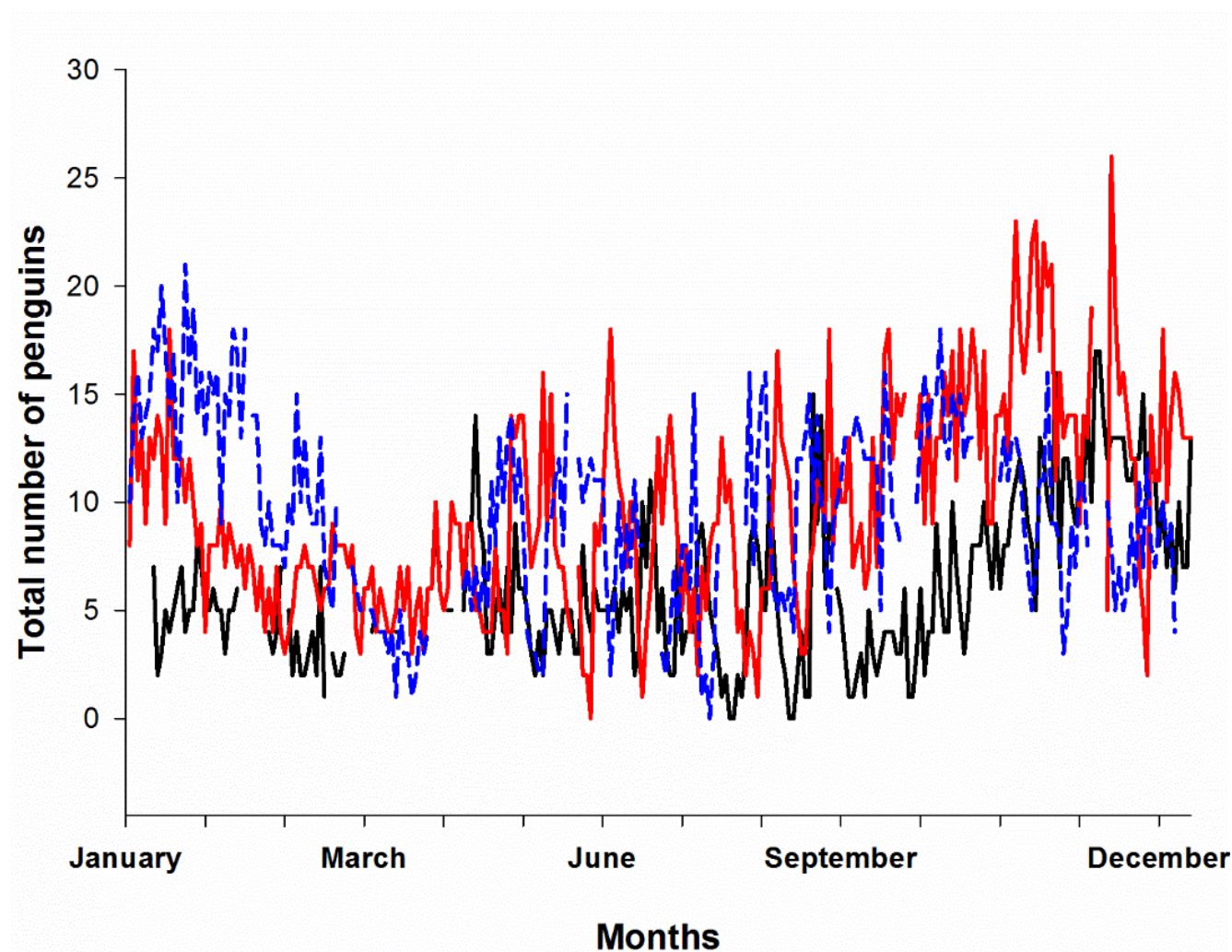


Figure 2. Daily attendance of little penguins on Granite Island in 2016 (black), 2017 (red) and 2018 (blue)

Disturbance

During the night counts, significant disturbances to the penguins were recorded on 23% (59/253) of the monitored nights. The disturbances include: unauthorised vehicles, dogs (on or off leash), bikes (birds were seen frighten by cyclists with lights), and people wanderings or actively searching for penguins using white torches or flashes (see Figure 3). Such disturbances have increased since 2012-2016, when they were recorded in less than 2% of the monitored nights (Figure 4). It should also be noted that these percentages represent the number of nights with disturbance, not the total disturbance, as more than one disturbance is generally recorded per night (i.e., in one night, one bird was flashed by wanderers while another bird was frightened by three cyclists).

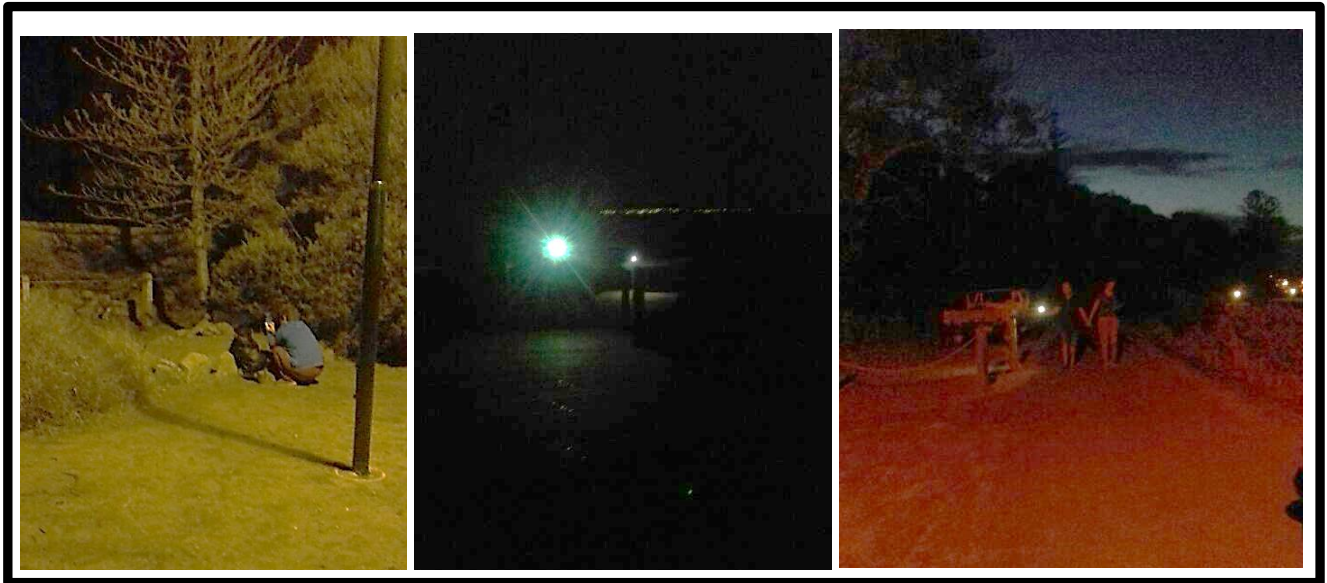


Figure 3. Evidence of disturbances occurring on Granite Island over a single night. The photos were taken during the night tours of wanderers not on a tour taking flash photos of the birds and walking with white torches.

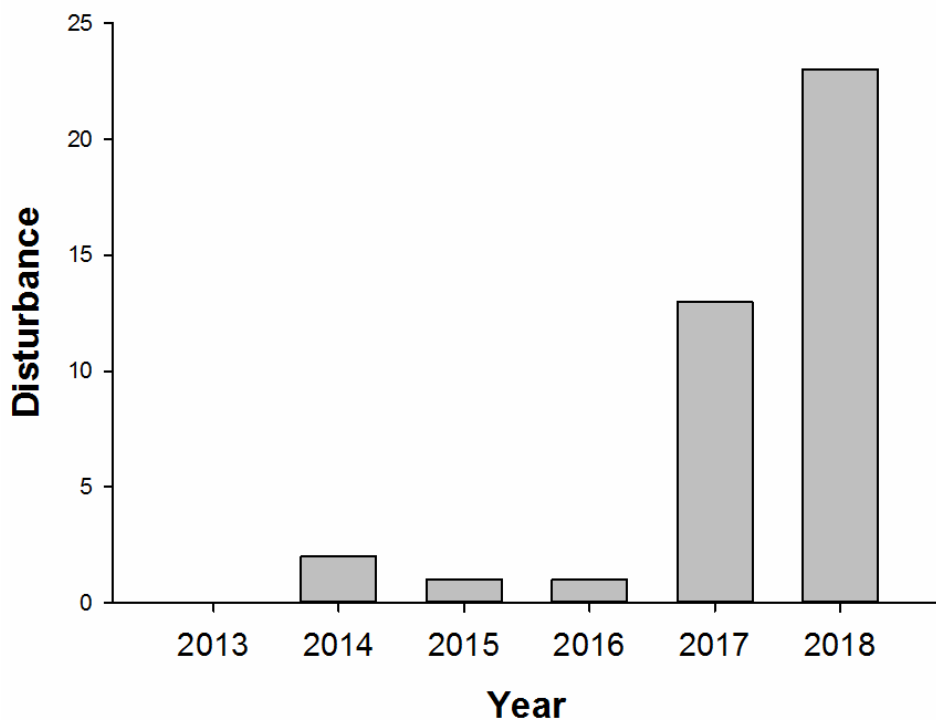


Figure 4. Percentage of nights when significant disturbances were recorded during the night tours on Granite Island between 2012 and 2018.

In addition, an increase in rat presence during the night tours was recorded since 2016. In 2018, rats were noted as present for 16% of the monitored nights (Figure 5); 30% of those nights had numbers higher than usual. In 2017 and 2016, rats were noted as present for 20% and 10% respectively of the monitored nights, while between 2012 and 2015, rats were only recorded as present for 2% of the nights (Figure 5).

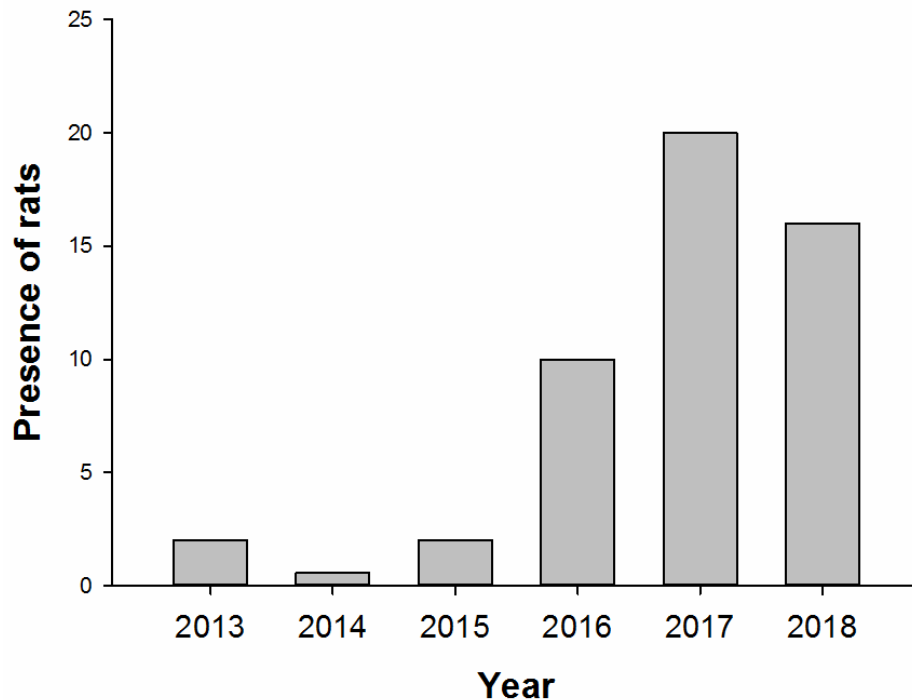


Figure 5. *Percentage of nights when rats were recorded as present during the night tours on Granite Island between 2012 and 2018.*

Additional disturbances to the penguins include regular festivals and concerts late at night, construction works on the island and the proposed upgrade of the tram tracks (expected in May-June 2019).

In 2018, several construction works were conducted on Granite Island during the breeding and moulting season of the penguins. One example is the move of the caravan next to the old penguin centre, which was located next to an active nest with breeding birds. As a result of the disturbance caused by the move (see Figure 6), the parents stopped feeding before their chicks were ready to fledge and the two chicks had to be delivered to AMRO. Observations in March 2019 shows that the parents have returned to the nest but are still extremely wary when approaching the area.

Following similar disturbance, another chick from another nest fledged early. In addition, several moulters during the moulting season moved between nests, which is of concern considering how vulnerable the birds are during moulting. None of these works were conducted in consultation with the Penguin Ecologist and stress to the birds could have been avoided with proper guidance.

Regular festivals and concerts (approx. 13 over a 3-months period) were also scheduled late at night during the penguins' breeding and moulting season, which raise concerns regarding acoustic and light disturbance to the penguins as well as increased unmonitored foot traffic on the island at night.



Figure 6. *Photos of the disturbance to the nest – the location of the nest is indicated with a red arrow.*

The tram track is expected to be upgraded in May-June 2019. Two issues arisen with this proposed upgrade. First, this upgrade was originally scheduled earlier in the year when birds were breeding and moulting, which is when little penguins are most susceptible to disturbance. On hearing of this timing, the Flinders University research team advised for the tram track upgrade to be delayed until the end of the breeding and moulting periods. However, there is no direct consultation with the Penguin Ecologist on this proposed work and the research team only heard about the work by chance. Additionally, as part of this upgrade, it is proposed to clear shrubs and other vegetation adjacent to the tracks (see Figure 7), which currently gives shelter to penguins returning at dusk from foraging. This vegetation is particularly important for the birds to rest before crossing the main road and facing the gauntlet of the chicks at the nest. Revegetation of suitable cover species should be undertaken, and additional areas planted to offer more protection and cover after penguins emerge from being at sea.



Figure 7. Photo of the site of the proposed upgrade that will impact little penguins – the location of the vegetation used by the birds when returning from sea is indicated with a red circle.

Population Census

Granite Island

Population census on Granite Island was conducted on 28th of September 2018 with 37 volunteers. A total of 22 active nests were found on the day of the census and the population estimation for Granite Island was 44 adult penguins (Figure 8; Table 3). Out of the 22 occupied nests, seven (32%) showed signs of breeding activity at the time of the census.

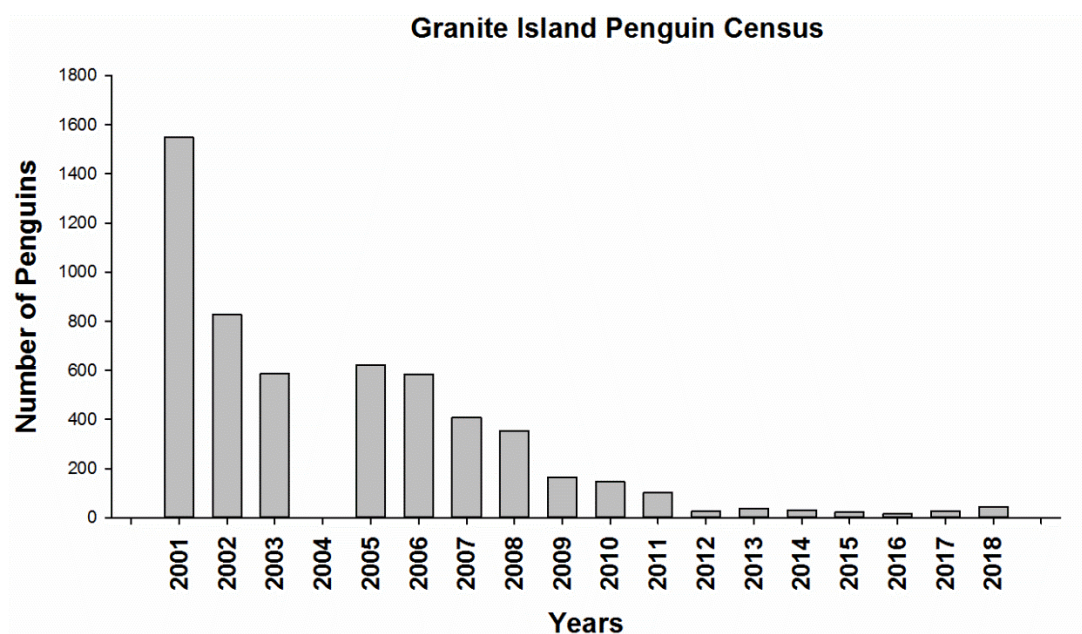


Figure 8. Estimated population size of little penguins on Granite Island between 2001 and 2018

Troubridge Island

Population census on Troubridge Island was conducted over three days (9-11th of October 2018) by a team of three people. The census was conducted over six quadrats of varying density and the calculations showed a total of 248 active nests for the whole island (with 38% of the active nests showing signs of breeding activity). This estimates 496 adults present on Troubridge Island at the time of the census (Figure 9; Table 3).

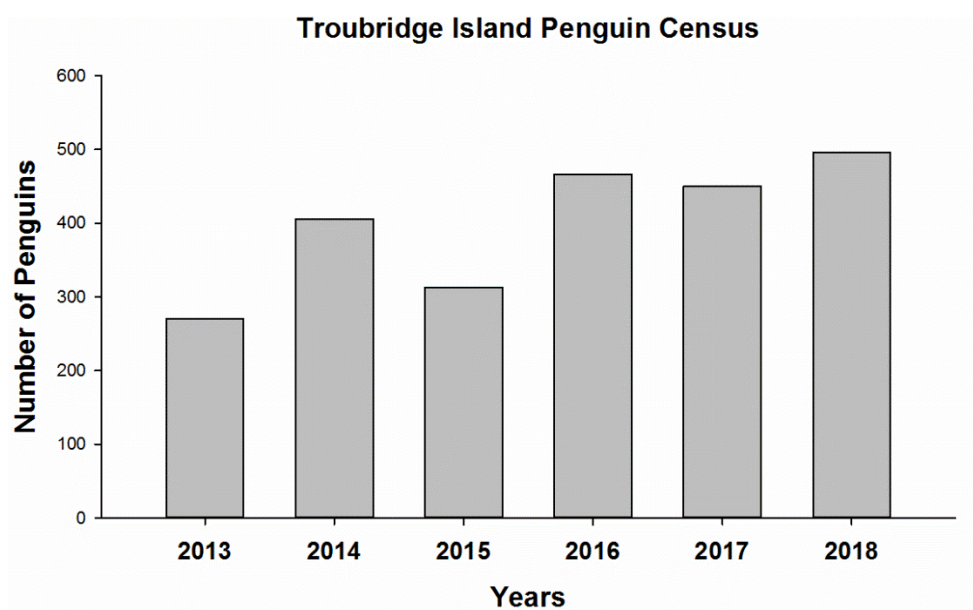


Figure 9. Estimated population size of little penguins on Troubridge Island between 2013 and 2016

Wardang Island

Wardang Island was visited seven times between October 2016 and May 2018 by the local rangers, with and without the Penguin Ecologist and students. Thirty-three percent of the coastline was searched over the years, via random searches and using information from the Aboriginal rangers. The average number of birds per km varied between areas, with an average of 23 birds per km; some areas showed no sign of penguin presence. The total population of Wardang Island in 2018 was estimated at 279 adult penguins (Table 3).

Goose Island

Goose Island was searched for active nests on the 30th of June 2017 by the local rangers and on the 8th of May 2018 by the Penguin Ecologist, the local rangers and two students. In both years, most of the active nests were found on the north side of the island. In 2017, a total of 11 active nests (and 26 inactive nests) was found, and the population estimation for Goose Island was estimated at 22 adult penguins. In 2018, a total of 19 active nests (and 27 inactive nests) was found, and the population estimation for Goose Island was 38 adult penguins (Table 3).

Spilsby Island

Spilsby Island was visited on 14th of August 2018 and searched for the presence of little penguins by a team of three people along two transects (north and south). A total of 35 active nests were found along the north transect (1km) and 51 active nests were found along the south transect (300m); 30% of the active nests found showed evidence of breeding activity. A survey of the island showed that a definite 2% of the coastline was inhabited by little penguins, which brings the population number to 410 adult penguins (Table 3).

Hareby Island

Hareby Island was visited on 14th of August 2018 and searched for the presence of little penguins by a team of three people along four transects: two on the north coast and two on the south coast. A total of 13 active nests (20 inactive nests) and seven active nests (16 inactive nests) were found along the south and north transects respectively; 15% of the active nests found showed evidence of breeding activity. The total population of Hareby Island in 2018 was estimated at 60 adult penguins (Table 3).

Smith Island

Smith Island was visited on 15th of August 2018 and searched for the presence of little penguins by a team of three people along one transect (25% of the coastline). No evidence of little penguins' presence was found, which aligns with results of another survey conducted on Smith Island in 2016 (Sarah-Lena Reinhold, pers. com; Table 3).

English Island

English Island was visited on 15th of August 2018 and searched entirely for the presence of little penguins by a team of three people. No evidence of little penguins' presence was found. The island appears to be a breeding colony of Australian sea lions; approx. 40 individuals were seen with a mixture of males, females with pups and juveniles (Table 3).

Rabbit Island

Rabbit Island was visited on 16th of August 2018 and searched for the presence of little penguins by a team of three people along one transect (25% of the coastline). Only one active nest (with one adult penguin, not breeding) was found along this transect. However, a habitat survey showed that the whole island was suitable for little penguins and another nest with two chicks close to fledgling was found in the middle of the island. The total population of Rabbit Island in 2018 was estimated at eight adult penguins based on a density of four birds per km (Table 3).

Louth Island

Louth Island was visited on 16th of August 2018 and searched for the presence of little penguins by a team of three people along two transects (east and west) and a total of 10 active nests were found; 30% of the active nests found showed evidence of breeding activity. A survey of the island showed that a definite 2.5km of the coastline was inhabited by little penguins, which brings the population number to 50 adult penguins (Table 3).

Colony	2018 survey	Previous survey	Historical Estimate	References
Granite Island	44	22 in 2015	approx. 100-1000 in 1962-1992	Copley 1996; Wiebkin 2011; DEWNR 2016; Colombelli-Négrel 2018
Troubridge Island	496	1966 in 2013	3000-5000 in 1966-1992	Copley 1996; Wiebkin 2011; Bool and Wiebkin 2013; DEWNR 2016; Colombelli-Négrel 2018
Wardang Island	279	8000 in 2004	none	Lawley 2004; Wiebkin 2011; DEWNR 2016; Colombelli-Négrel 2018
Goose Island	38	20 in 2005	Breeding colony present in 1981	Robinson et al. 1996; Wiebkin 2011; DEWNR 2016
Spilsby Island	410	100 in 2011	few thousand in 2000-2005	Wiebkin 2011; DEWNR 2016
English Island	0	0 in 2011	Breeding colony present in 1980	Robinson et al. 1996; Wiebkin 2011; DEWNR 2016
Louth Island	50	sighted in 2017, 2018	none	-
Rabbit Island	8	none	Breeding colony present in 1976	Robinson et al. 1996; Wiebkin 2011; DEWNR 2016
Hareby Island	60	500 in 2008	Present in 1979	Robinson et al. 1996; Wiebkin 2011; DEWNR 2016
Smith Island	0	none	Present in 1982	Wiebkin 2011; DEWNR 2016

Table 3. Population estimates and historical records for the little penguin colonies surveyed in 2018.

Additional data

Habitat preference of little penguins

None of the habitat variables measured explained little penguin presence/absence or density. At the meso level, none of the island characteristics (distance to the nearest colony, island size, water depths, maximum height and number of landing sites) explained little penguins' population size (low, high). At the topo level, none of the quadrat characteristics (distance to next living colony, vegetation cover, dominate shrubs species, dominate ground plant species, predator presence, competitor presence, slope and distance to nearest landing site) explained little penguins' nesting density. At the micro level, the models that best explained the effect of the nest characteristics (entrance orientation, nest type, plant species and vegetation cover) on penguin presence (active vs inactive) were the null model and the plant species model; yet, there was no significant variation in plant species in relation to nest activity.

Time budgets and thermoregulation

Time budgets differed between age categories of little penguins, with chicks exhibiting shorter crouching and standing bouts, longer dozing bouts and engaging in gular fluttering more often than adults. Adult, but not chick, postural adjustments were positively correlated to the environmental variables. In response to sudden intense heat, both adults and chicks made some postural adjustments by reducing their time sitting and increasing their time standing.

Environmental conditions and breeding success

Warmer sea surface temperatures before the breeding season were associated with earlier breeding. There was no correlation between sea surface temperatures and breeding success, nor between ambient air temperature and breeding success. Increased chlorophyll-a concentrations prior to breeding did not influence the start of the breeding season. High rainfall positively influenced both the timing and success of breeding, and wind speeds negatively impacted breeding success.

Behavioural and heart rate responses to stressors

Little penguins elicited both a significant physiological (increase in HR) and behavioural (increase in vigilance) response to all disturbance, except to the control sound. Preliminary analyses showed that little penguins responded with more vigilance to dog barks, followed by human voices. Individuals that were particularly vigilant were also particularly physiologically responsive.

VI. DISCUSSION

The main findings of this study are: (1) Granite Island population continued to have a high breeding success; (2) Granite and Troubridge Island populations showed stable trends; but (3) human disturbance on Granite Island increased from <2% of the monitored nights prior to 2016 to 23% in 2018; (4) none of the habitat variables measured explained little penguin presence/absence or density; (5) chicks engaged in longer dozing bouts and in thermoregulation behaviours more often than adults; (6) sea surface temperatures before the breeding season were important to predict the start of the breeding season, and breeding success in South Australia was influenced by rainfall and wind speeds; and (7) little penguins responded more strongly to dog barks compared to other disturbances. In addition, this report presents updated results of population surveys on Wardang (279 adults), Goose (38 adults), Spilsby (410 adults), Hareby (60 adults), English (0 adult), Rabbit (8 adults), Louth (50 adults), and Smith Islands (0 adult).

In the Yorke Peninsula, the Troubridge Island population is showing a stable trend since 2013 (Figure 9). The distribution of active nests found within the six monitored quadrats in 2016, 2017 and 2018 showed consistent densities between years, supporting the accuracy of this method in recording total population size. As recommended in a previous report (Colombelli-Négrel 2018), it is suggested to alternate between a full population census and quadrat census to minimise disturbance.

Surveys on Goose Island showed that population size was 22 adults in 2017 and 38 adults in 2018. Little penguins on Goose Island were recorded as present in the early 1980s and 1990s but with no record of actual population size (reviewed in DEWNR 2016). A more recent survey recorded less than 20 breeding pairs in 2005 (Wiebkin 2011), and the population is currently listed as “unknown trend (data deficient)” (DEWNR 2016). These recent surveys suggest that the population may be small but stable; however, additional surveys on Goose Island are needed to confirm this trend.

Previous visits in 2016 estimated the total numbers of little penguins for Wardang Island to be approx. 256 birds, based on 64 adults per km and four active breeding areas within the island (Colombelli-Négrel 2017a). The final survey presented here estimates this population at 279 little penguins. This is much lower than the previous estimation of ~8000 penguins done in 2004 (Lawley 2004); however, no information is available on the methods used in 2004 and caution should be applied when comparing these estimates. Wardang Island is also one of the few islands in South Australia where cats are still present (see DEWNR 2016, Colombelli-Négrel pers. obs.), and several cats were observed hunting on the island during the visits. Cats are recognised predators of little penguins in Australia and can have major impacts on penguin populations (Masters 2007; Stahel and Gales 1987; Stevenson and Woehler 2007; Colombelli-Négrel and Tomo 2017); it is therefore highly recommended that cat control be implemented on this island to avoid a decrease of the population (see also DEWNR 2016).

This report presents the results of recent surveys on several islands in the Spencer Gulf. Both English and Smith Islands showed no evidence of penguin presence, confirming that the population on English Island is extinct (DEWNR 2016). Only eight adults were estimated present on Rabbit Island but only one nest with evidence of breeding was found. Similarly, a survey in 2008 reported sighting only one breeding nest (see DEWNR 2016), suggesting that this colony is extremely small, may not be considered as a colony or may become extinct soon. While Louth Island was not previously recorded as a little penguin colony, local fisherman reported several sightings of little penguins on this island in 2017 and 2018, and breeding little penguins were found in 2018 with an estimated population size of 50 adults. As there is no record for this population, it is not possible to estimate population trend, but it is conceivable that the birds breeding on Louth Island originate from Rabbit Island.

Hareby Island was presumed stable (DEWNR 2016) with 500 individuals estimated to be present on this island in 2005 (Wiebkin 2011). However, this was the first and only estimation conducted for this colony, as penguins were only recorded as present in the late 1970s/early 1980s and again in 2009 (DEWNR 2016). The present survey estimated the Hareby population at 60 little penguins, suggesting that this population might have decreased in recent years. But additional surveys are needed to confirm this trend and caution should be applied when comparing these estimates due to differences in the timing and methodology of the surveys.

Spilsby Island was considered declined (DEWNR 2016) with less than 10 individuals estimated to be present on this island in 2010 (Wiebkin 2011). The present survey however estimates the Spilsby population at 410 adults with >80 active nests sighted. It should also be noted that most of the active nests were found in the southern part of the island, while prior discussions with local habitants suggested that most birds were located on the north side, which may have biased previous estimates. Considering the size of this population and its location in the Spencer Gulf, it is recommended to continue monitoring this colony as ongoing monitoring is critical for coordinated state wide assessments (see DEWNR 2016).

While there has been no predation at active nests on Granite Island since 2012 (see also Colombelli-Négrel and Kleindorfer 2014; Colombelli-Négrel 2015b; Colombelli-Négrel and Tomo 2017), rat numbers have increased significantly since 2016 (Figure 5). This is of concern considering that previous studies suggested that water-rats and black rats were potential nest predators of little penguins on Granite Island (Bool et al. 2007). The introduction of coordinated baiting programs in 2006 as well as the previous closure of the restaurant and other food outlets on the island resulted in a subsequent reduction in rat numbers prior to 2016. However, with the recent increased visitation and new food outlets installed, there is a need to review waste management, and the use of waste containers and rats/gulls' proof bins. On-going rat baiting with suitable rodenticides will be important in managing rat populations and enabling penguin recovery.

This report confirms that the Granite Island population is stable since 2012, with a slight increase since 2017 and a high number of fledglings produced in 2018. However, survival rates of little penguins on Granite Island are extremely low for both adults (16%) and fledglings (2%) (Colombelli-Négrel 2015b). This means that only 0-1 of those 25 fledglings is expected to survive until breeding maturity, and that more than 200 fledglings need to be produced per year to increase population size by 10%. In addition, breeding success in little penguins is strongly correlated with variations in oceanographic conditions and prey availability (e.g., Cannell et al. 2012; Berlincourt & Arnould 2015; Saraux et al. 2016; this study), suggesting that breeding success could decrease in subsequent years as a result of changes in local environment.

As stated in several previous reports (Colombelli-Négrel 2017a, 2018), urgent measures need to be taken to decrease disturbances from human activities on this island, such as direct harm to individual

penguins (due to wanderers at night), damage of nesting habitat or restriction of access to nest areas, increases in noise or light around nesting areas or dog disturbance (NPWS 2000; Colombelli-Négrel 2017a, b; this study).

Construction works (even minor) should not be conducted during the breeding and moulting season of the little penguins and should be conducted in consultation with the Penguin Ecologist. The best months for construction works are outside of their breeding and moulting periods, from April to June, when little penguins have likely finished with their breeding and moulting and are less likely to be stranded in their nests. The likelihood of disturbance to little penguins outside this time is expected to be high (Morgan 2011; Colombelli-Négrel 2017b).

During the night, human and dog disturbances on this island increased from <2% (prior to 2016) to 23% in 2018. While no dog predation has been reported recently on Granite Island, dogs are one of the most significant threat to little penguins (Dann 1992) in Australia and have negatively impacted other penguin colonies in South Australia (e.g., Kangaroo Island; Wiebkin 2011). Results from Anna Hayes study (this report) showed that little penguins responded more strongly to dog barks compared to the other disturbances, stressing the importance to stop disturbance from dogs being walked on Granite Island (see also Williams et al. 2009). It is recommended to increase awareness in dog owners and to improve signage on the island as signs prohibiting dogs on Granite Island are poorly visible.

In addition, regular night festivals and concerts that attracted additional foot traffic and increase anthropogenic disturbance were scheduled during the penguins breeding and moulting seasons. Increase human activity brings a range of issues that includes noise and light disturbance, inappropriate behaviour around nests, and increase of hard waste and diseases. In a wide range of animals, noises and light can impair sensory capabilities used for communication, predator or prey detection and spatial navigation (reviewed in Francis and Barber 2013). Little penguins have very sensitive eyesight and generally avoid lit places when landing or nesting (Rodríguez et al. 2016). Disturbance from noise may also inhibit the initiation of breeding at the beginning of the breeding season, result in lower breeding success and may prevent individuals from returning from fishing at sea resulting in chicks not being fed or in partners not being relieved. Animals perceive noises and human disturbances as threats that generate self-preservation responses (Frid and Dill 2002). When continuously exposed to stressful factors, such as anthropogenic noises and human disturbances, animals experience chronic stress (Cyr and Romero 2007) that can impair their ability to resist diseases (Blickley and Patricelli 2010), lead to stress-related diseases (Mortimer and Lill 2007), suppress their immune system (Cyr and Romero 2007), or disrupt their foraging abilities (Angelier et al. 2008), which in turn can impact adult survival and population trends. Therefore, the fact that little penguins may remain in a noisy area cannot be interpreted as an indication that they are not impacted by elevated sound levels, because there are many potential costs associated with noise exposure, and individuals and populations differ in their responses to elevated noises (reviewed in Francis and Barber 2013).

VII. DIRECTIONS FOR FUTURE RESEARCH

- 1) Continue long-term annual monitoring of populations trends, survival, threats and breeding success across targeted populations in the Gulf St Vincent to build reliable databases.
- 2) Conduct population surveys and identify threats at strategic sites to get a better understanding of the little penguin status in South Australia as outlined in Dann (2016), DEWNR (2016) and Colombelli-Négrel (2017a). Ongoing monitoring is critical for coordinated state wide assessments (see DEWNR 2016).
- 3) Investigate the long-term impacts for little penguin population trends of anthropogenic light and noise disturbance.
- 4) Assess spatial variation of predation by long-nosed fur seals across more colonies within South Australia to measure the long-term impacts for little penguin population trends as outlined in Dann (2016).
- 5) Identify parasite infections, viruses and vectors across colonies with different population trends to better assess their impact on population trends.
- 6) Investigate variation in food availability, foraging effort and resource use between colonies and their impact on population trends.
- 7) Determine to which extent little penguins can respond to environmental change (i.e., introduced predators, disturbance from human activities and climate change).
- 8) Develop population viability analysis models to explore how variation in each of the parameters listed above and identified in previous reports affect population trends and population vulnerability.

VIII. MANAGEMENT RECOMMENDATIONS

- 1) Improve security and decrease human disturbance on Granite Island; the suggested actions include but are not limited to:
 - i. prohibit access to the public at night (unless on an authorised tour);
 - ii. prohibit/limit the number of festivals and concerts that increase human traffic at night during breeding and moulting to prevent further stress on the resident birds; if such events were to be scheduled, additional security measures would need to be enforced;
 - iii. improve signage around the island and on the mainland about such limitations and the consequences of human disturbances;
 - iv. conduct all construction works outside of the little penguins' breeding and moulting seasons (April and June) and in consultation with the Penguin Ecologist to mitigate impacts on little penguins;
- 2) Create a Granite Island working group to ensure the long-term survival of little penguins on Granite Island and improve communication between all parties involved. Members should include but are not limited to:
 - i. Penguin Ecologist (Dr Diane Colombelli-Négrel) and Flinders researchers (Stephen Hedges in particular),
 - ii. DEW rangers (Seiji Iwao in particular),

- iii. DEW (Lisien Loan - Manager, Parks and Sustainable Landscapes),
 - iv. NR AMLR Manager coast and marine (Tony Flaherty),
 - v. BirdLife Australia Sharing our Shores with Coastal Wildlife programme (Alesia Lamanna/Emma Stephens),
 - vi. Friends of Granite Island,
 - vii. South Coast Environment Centre (Gayle Mayles),
 - viii. Oceanic Victor, and
 - ix. Council of Victor Harbor.
- 3) Change the regulations to increase protection of shorebirds and seabirds on land. A Wildlife Conservation Regulation could be made under section 68(1)(c) of the National Parks and Wildlife Act 1972 similar to the disturbance measures introduced for marine mammals under the National Parks and Wildlife (Protected Animals-Marine Mammals) Regulations 2010. Such regulations could include temporary closures as an alternative to full site closures and deployment of signage to manage activities likely to disturb roosting shorebirds, beach-nesting birds, or seabird rookeries.
 - 4) Decrease dog disturbance on Granite Island: it is recommended to increase awareness in dog owners and to improve signage on the island as signs prohibiting dogs on Granite Island are poorly visible.
 - 5) Re-start rat control on Granite Island to maintain high breeding performance. Increase in rat density is demonstrated in this report and is continuing to increase; rats on Granite Island are rated as 'very high' risk to little penguins and their eradication is listed as a priority (DEWNR 2016).
 - 6) Eradicate cats on Wardang Island to eliminate potential predation risks on little penguins; cats on Wardang Island are rated as 'very high' risk to little penguins and their eradication was listed as a priority (DEWNR 2016).
 - 7) Implement additional measures to limit Troubridge Island reduction in size (see Colombelli-Négrel 2017a).
 - 8) Review and update the conservation management priorities for little penguin populations in Gulf St Vincent (Wiebkin 2011).

IX. COMMUNITY ENGAGEMENT

Thirty-seven volunteers participated in the Granite Island penguin census in September 2018. Three Honours students and one third-year student worked on little penguin related projects. A presentation was given to the public on Granite Island on 28th of September, and an interview for The Advertiser on the same day. An interview was given to two year-12 students for their research assignment. Our team raised awareness about penguin conservation with 60+ people.

X. ACKNOWLEDGEMENTS

Thank you to the Adelaide and Mt Lofty Ranges Natural Resources Management Board, Nature Foundation SA, Birds SA, the Nature Conservation Society of South Australia, the Field Naturalists Society of South Australia, Australian Geographic, the Lirabenda Endowment Research Fund, Alongside Wildlife Foundation and Flinders University for funding. Special thanks to Tony Flaherty (Coast and Marine Manager, Natural Resources Adelaide and Mt Lofty Ranges) and Sonia Kleindorfer for their continued support with the project. Thanks to Stephen Hedges, Sarah-Lena Reinhold, Bianca Johnson and all the volunteers who helped collect the data. Thanks to Chris and Judy Johnson for access to Troubridge Island and to Barossa Helicopters and Rhyen Baffett for transport to the islands in the Spencer Gulf. Thanks to the local rangers on Wardang and Goose Islands (in particular Jasmine Swales and Max Barr) for their help with the surveys. Finally, thanks to the Whale Centre and Ben Boothby for support during the little penguin census.

XI. REFERENCES

- Angelier F, Giraudeau M, Bost CA, Chastel O (2008). Corticosterone and foraging behaviour in a diving seabird: The Adélie penguin, *Pygoscelis adeliae*. *General and Comparative Endocrinology* 156: 135-144.
- Auricht HCC, Clarke KD, Lewis MM, Mosley LM (2018). Have droughts and increased water extraction from the Murray River (Australia) reduced coastal ocean productivity? *Marine Freshwater Research* 69: 343-356.
- Berlincourt M, Arnould JPY (2015). Influence of environmental conditions on foraging behaviour and its consequences on reproductive performance in little penguins. *Marine Biology* 162: 1485-1501.
- Blickley JL, Patricelli GL (2010). Impacts of anthropogenic noise on wildlife: Research priorities for the development of standards and mitigation. *Journal of International Wildlife Law and Policy* 13: 274-292.
- Bool NM, Wiebkin AS (2013). Census of Little Penguin Population Troubridge Island. Report to the Department for Environment and Heritage, Adelaide.
- Bool, N.M., Page, B. and Goldsworthy, S.D. (2007). What is causing the decline of little penguins (*Eudyptula minor*) on Granite Island, South Australia? SARDI Adelaide.
- Cannell BL, Chambers LE, Wooller RD, Bradley JS (2012). Poorer breeding by little penguins near Perth, Western Australia is correlated with above average sea surface temperatures and a stronger Leeuwin Current. *Marine and Freshwater Research* 63: 914-925.
- Colombelli-Négrel D (2015a). Penguin monitoring and conservation activities in Gulf St Vincent between July 2014 and June 2015. Report to Adelaide and Mount Lofty Ranges NRM Board.
- Colombelli-Négrel D (2015b). Low survival rather than breeding success explains little penguin population decline on Granite Island. *Marine and Fresh Water Research* 6: 7965-7975.
- Colombelli-Négrel D (2016a). Penguin monitoring and conservation activities in Gulf St Vincent between July 2015 and June 2016. Report to Adelaide and Mount Lofty Ranges NRM Board.
- Colombelli-Négrel D (2016b). Both natural selection and isolation by distance explain phenotypic divergence in bill size and body mass between South Australian little penguin colonies. *Ecology and Evolution* 6: 7965-7975.
- Colombelli-Négrel D (2017a). Penguin monitoring and conservation activities in the Gulf St Vincent, July 2016 – June 2017. Report to Adelaide and Mount Lofty Ranges NRM Board.
- Colombelli-Négrel D (2017b). Ecological assessment of the impacts of the development of the boat ramp on little penguins and their habitat at Emu Bay. Report to the Kangaroo Island Council.
- Colombelli-Négrel D (2018). Penguin monitoring and conservation activities in Gulf St Vincent between July 2017 and June 2018. Report to Adelaide and Mount Lofty Ranges NRM Board.
- Colombelli-Négrel D (2019). Benefits, costs and trade-offs of nesting habitat selection in little penguins. *Journal of Ornithology* 160: 515-527.

- Colombelli-Négrel D, Kleindorfer S (2014). Penguin monitoring and conservation activities in Gulf St Vincent between July 2013 and June 2014. Report to Adelaide and Mount Lofty Ranges NRM Board.
- Colombelli-Négrel D, Tomo I (2017). Identification of terrestrial predators at two Little Penguin colonies. *Australian Field Ornithology* 34: 1-9.
- Colombelli-Négrel D, Smale R (2018). Habitat explained micro-geographic variation in little penguin growl calls. *The Auk* 135: 44-59.
- Copley PB (1996). The status of seabirds in South Australia. In: Ross GJB, Weaver K, Grieg JC (Eds). *The Status of Australia's Seabirds: Proceedings of the National Seabird Workshop*, Canberra, 1-2 November 1993. 139-180. Biodiversity Group, Environment Australia, Canberra.
- Cyr NE, Romero LM (2007). Chronic stress in free-living European starlings reduces corticosterone concentrations and reproductive success. *General and Comparative Endocrinology* 151: 82-89.
- 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 (2016). Independent report on the risk assessment for little penguins in South Australia including management recommendations and priorities. Report to DEWNR, Adelaide.
- Department of Environment, Water and Natural Resources (2016). Conservation risk assessment report for little penguins in South Australia. DEWNR Technical Report 2016/33, Adelaide.
- Francis CD, Barber JR (2013). A framework for understanding noise impacts on wildlife: an urgent conservation priority. *Frontiers in Ecology and the Environment* 11: 305-313.
- Frid A, Dill LM (2002). Human-caused disturbance stimuli as a form of predation risk. *Conservation Ecology* 6: 11.
- Lawley J (2004). Preliminary study of little penguins on Wardang Island 27th to 30th October 2004. Unpublished report.
- Maher D (2014). Conservation Status of Little Penguins in Australia. Draft prepared in Nov 2014, 50pp.
- Marchant S, Higgins PJ (1990). *Handbook of Australian, New Zealand and Antarctic Birds*. Oxford University Press, Melbourne.
- Masters P (2007). *Cats on Kangaroo Island: Ecological characteristics and Community Management*, Report to Kangaroo Island Natural Resources Management Board, Kingscote.
- Morgan H (2011). *Stanley Penguin Habitat Management Plan*. Bushways Environmental Services Tasmania.
- Mortimer A, Lill A (2007). Activity-related variation in blood parameters associated with oxygen transport and chronic stress in little penguins. *Australian Journal of Zoology* 55: 249-256.
- NPWS (2000). *Endangered Population of Little Penguins Eudyptula minor at Manly, Recovery Plan*. NSW National Parks and Wildlife Service, Hurstville.

- Peucker AJ, Dann P, Burridge CP (2009). Range-wide phylogeography of the little penguin (*Eudyptula minor*): evidence of long-distance dispersal. *The Auk* 126: 397-408.
- Robinson A, Canty P, Mooney T, Rudduck P (1996). South Australia's Offshore Islands. Biological Survey South Australia. Department of Environment and Natural Resources, South Australia.
- Rodríguez A, Dann P, Chiaradia A (2017). Reducing light-induced mortality of seabirds: High pressure sodium lights decrease the fatal attraction of shearwaters. *Journal for Nature Conservation* 39: 68-72.
- Saraux C, Chiaradia A, Salton M, Dann P, Viblanc V (2016). Negative effects of wind on individual foraging performance and breeding success in little penguins. *Ecological Monograph* 86: 61-77.
- Stahel, C. and Gales, R. (1987). Little Penguin: Fairy Penguins in Australia. New South Wales University Press, Kensington.
- Stevenson C, Woehler EJ (2007). Population decreases in Little Penguins *Eudyptula minor* in southeastern Tasmania, Australia, over the past 45 years. *Marine Ornithology* 35:61-66.
- Wiebkin AS (2011). Conservation management priorities for little penguin populations in Gulf St Vincent. Report to Adelaide and Mount Lofty Ranges Natural Resources Management Board. SARDI Research Report Series No.588. Adelaide.
- Williams KJ, Weston MA, Henry S, Maguire GS (2009). Birds and beaches, dogs and leashes: Dog owners' sense of obligation to leash dogs on beaches in Victoria, Australia. *Human Dimensions of Wildlife* 14: 89-101.