A TRIAL TRANSLOCATION OF LITTLE PENGUIN *EUDYPTULA MINOR* FLEDGLINGS

NICHOLAS CARLILE[1], DAVID PRIDDEL[1], LISA O'NEILL[2], ROBERT WHEELER[1] & ERNA WALRAVEN[3]

[1]*Office of Environment and Heritage, PO Box 1967, Hurstville, NSW 2220, Australia (nicholas.carlile@environment.nsw.gov.au)*
[2]*PO Box 3303, North Nowra, NSW 2541, Australia*
[3]*Taronga Conservation Society, Bradley's Head Road, Mosman, NSW 2088, Australia*

Received 25 March 2014, accepted 3 June 2015

SUMMARY

CARLILE, N., PRIDDEL, D., O'NEILL, L., WHEELER, R. & WALRAVEN, E. 2015. A trial translocation of Little Penguin *Eudyptula minor* fledglings. *Marine Ornithology* 43: 223–229.

A translocation of wild-bred and captive-bred Little Penguin *Eudyptula minor* fledglings was trialled to reinforce (augment) an urban population of this species in Sydney Harbour, Australia. Over three breeding seasons (2004/05 to 2006/07), a total of 44 wild-bred fledglings from nearby Lion Island and 19 captive-bred fledglings from local zoos were translocated to Store Beach, North Harbour, within Sydney Harbour. All translocated birds were implanted with a numbered microchip before release. During the same period, the North Harbour colony produced at least 327 fledglings, of which 113 were implanted with microchips prior to fledging. The North Harbour colony was monitored between 2005 and 2013 to identify any returning translocated or locally wild-bred birds. Three translocated wild-bred birds and 12 locally wild-bred birds are known to have returned to North Harbour, but no translocated captive-bred birds. One translocated wild-bred bird returned to Store Beach while the remaining two returned to adjacent headlands. The number of pairs of Little Penguin breeding on Store Beach, where threats are intensively managed, has increased from one in 2004 to nine in 2013. This study demonstrated that translocation of wild-bred fledglings is feasible. However, because of naturally low return rates, translocations of Little Penguins need to involve a large number of individuals, preferably taken from a sizeable donor colony, to be effective in reinforcing a threatened or declining population. The effectiveness of releasing captive-bred Little Penguins has yet to be demonstrated.

Key words: Little Penguin, *Eudyptula minor*, translocation, Sydney Harbour, New South Wales, Australia.

INTRODUCTION

Seabird translocations have been attempted for more than three decades (Kress & Nettleship 1988, Serventy *et al.* 1989, Bell *et al.* 2005), but only recently have techniques been refined sufficiently for these operations to be undertaken with confidence (Priddel *et al.* 2006, Miskelly *et al.* 2009). To date, most translocations have targeted Procellariiformes (albatrosses, petrels and shearwaters), exploiting the high degree of natal philopatry these species exhibit. There are no published accounts of translocation being used to establish new colonies of Sphenisciformes (penguins), although Gummer (2003) referred to Challies having developed translocation techniques for the Little Penguin *Eudyptula minor* in New Zealand during the 1980s and 1990s. By selecting young birds just before fledging, these techniques achieved return rates of translocated birds similar to those of birds that fledged from natal sites (Numata 1997).

The temporary relocation of adult penguins has been well documented. In 1995, following an oil spill in Tasmania off southern Australia, 1 800 Little Penguin adults were relocated 540 km from their breeding colonies following their rehabilitation to allow time for the clean-up of the shoreline at their colonies (Hull *et al.* 1998). Similarly, African Penguin *Spheniscus demersus* adults at threat from an oil spill near their natal colonies in 2000 were successfully relocated to remove them temporarily from the affected area (Barham 2006). Nestlings were also removed, hand-reared and released back onto two main breeding islands. Of those relocated penguins subsequently found ashore on one island, 71% had been released there (Barham *et al.* 2008). The return of adults to their breeding colony and translocated fledglings to their release site indicates a high level of philopatry. Such pioneering work suggests that translocation could be an effective means of restoring penguin colonies that have been severely depleted, and for which the threats have been partially or fully mitigated.

The Little Penguin is a common and widely dispersed species throughout the temperate waters of Australia and New Zealand (Marchant & Higgins 1990). Within Australia, breeding colonies occur predominantly around Bass Strait (Stahel & Gales 1987), with lesser numbers along the southern, southwestern and southeastern coastlines of the continent. Before European settlement, the Little Penguin bred at numerous sites on the Australian mainland but is now restricted largely to offshore islands, including Tasmania (Marchant & Higgins 1990, Fortescue 1995). It appears that most mainland colonies were extirpated by introduced predators (Reilly & Balmford 1975, Barton 1978, Reilly & Cullen 1979, Stahel & Gales 1987, Harrigan 1992, Norman *et al.* 1992). To date, there have been no attempts to re-establish any extinct colony.

Remarkably, the two remaining colonies of Little Penguin on the Australian mainland occur within the nation's two largest cities. In Melbourne, at least 260 breeding pairs nest along the St Kilda breakwater in Port Phillip Bay (Hogg pers. comm. 2010). In Sydney, approximately 50 breeding pairs nest along about 2.5 km of foreshore in North Harbour, but the colony was formerly much larger (Priddel *et al.* 2008).

Although the Little Penguin is of Least Concern nationally and globally (IUCN 2014), the population in Sydney is locally iconic and, in 1997, the New South Wales Government acted to prevent the local extinction of the population. Legislative controls were implemented to address all known threats, particularly adverse urban development. Developers are prohibited from destroying nesting sites, and must consider the proximity of penguin nesting areas when siting construction activities. Additionally, funding was made available to undertake recovery actions aimed at increasing breeding success and population size. Recovery actions include control of introduced Red Fox *Vulpes vulpes* and feral cats *Felis catus*; policing; public education; the installation of nest boxes (Bourne & Klomp 2003); regular marking and monitoring of the population (Priddel *et al.* 2008); and the recent introduction of a species-detector dog to locate nests (O'Neill unpubl. data). In 2002, legislative protection was further enhanced, including the imposition of substantial fines for persons approaching within 5 m of known penguin breeding sites or intentionally disturbing moulting birds.

The outcome of these conservation initiatives has seen the North Harbour population stabilise at 50–60 breeding pairs. Unfortunately, the occasional act of vandalism or predation of nesting birds by a rogue dog or fox continues to hamper population recovery. Recovery could be hastened by the translocation of penguins from nearby islands or the release of captive-bred birds of appropriate genetic lineage. Studies have demonstrated the movement of individuals between North Harbour and nearby Lion Island (Priddel *et al.* 2008) and have confirmed the interchange of genetic material (Peucker *et al.* 2009).

Preferably, expansion of the population would occur within areas of conservation reserve, where threats are minimal and more easily mitigated. Within the North Harbour foreshore lies Store Beach, which is part of the Sydney Harbour National Park (Figure 1). Here, public access is by boat only, and urban development, domestic dogs and camping are prohibited. An ongoing control program maintains fox and feral cat numbers at very low densities. In 2004/05 a single breeding pair of Little Penguin nested on Store Beach, the first in 25 years (Carlile unpubl. data). To increase potential nesting capacity at this site, 32 artificial nest boxes were installed in 2004/05 (unpubl. data), according to the design by Houston (1999) and Priddel and Carlile (1995).

Translocation utilizes the strong philopatric behaviour of Little Penguins (Reilly & Cullen 1981, Dann 1992) to return to the site of fledging (the recipient colony) when breeding age is attained. Successful augmentation of the population at Store Beach through translocation requires that the translocated birds both survive after release and later return to breed. The survival rate of wild fledglings from North Harbour and other Australian colonies has been studied (e.g. Dann & Cullen 1990; Priddel *et al*. 2008), but the survival of translocated or captive-bred Little Penguins after release into the wild is unknown.

Previous trials in New Zealand found that translocation of penguins was achieved most efficiently by moving fledglings within 2 d before their normal departure from the nesting area (Numata 1997). Young of this age are seldom fed by their parents (Stahel & Gales 1987), and their departure to sea is imminent. Chicks of fledging age are readily identified as they have little or no mesoptyle down left at 8 weeks of age (Stahel & Gales 1987).

The aims of this study were to (1) translocate wild-bred and captive-bred Little Penguin fledglings to North Harbour; (2) compare return and breeding rates of translocated wild-bred, translocated captive-bred and locally wild-bred fledglings; and (3) evaluate the effectiveness of these translocations in augmenting the breeding population. The source population for wild-bred donor birds was Lion Island Nature Reserve, located in Broken Bay, 28 km north of Store Beach (Fig. 1). Lion Island (8 ha) supports a population of approximately 300 breeding pairs of Little Penguin (Lane 1979) that is highly productive relative to most other colonies along the east coast of Australia (Rogers *et al.* 1995, Priddel *et al.* 2008). The donor birds from captive-bred populations were drawn from local zoos: Taronga Zoo and Sydney Aquarium.

METHODS

Translocation technique

All fledglings selected for translocation (captive-bred and wild-bred) were subjected to a rigorous health check by a veterinarian at the time of translocation, and only healthy birds weighing >800 g were released. Each translocated fledgling was microchipped by the insertion of a passive integrated transponder (PIT) tag under the skin (Trovan ID 100 microchips). They were transported in pet carriers in air-conditioned vehicles by road and then carried on foot the 300 m to Store Beach. Wild-bred fledglings from Lion Island were transported for about 2 hours, 6 km by boat and 32 km

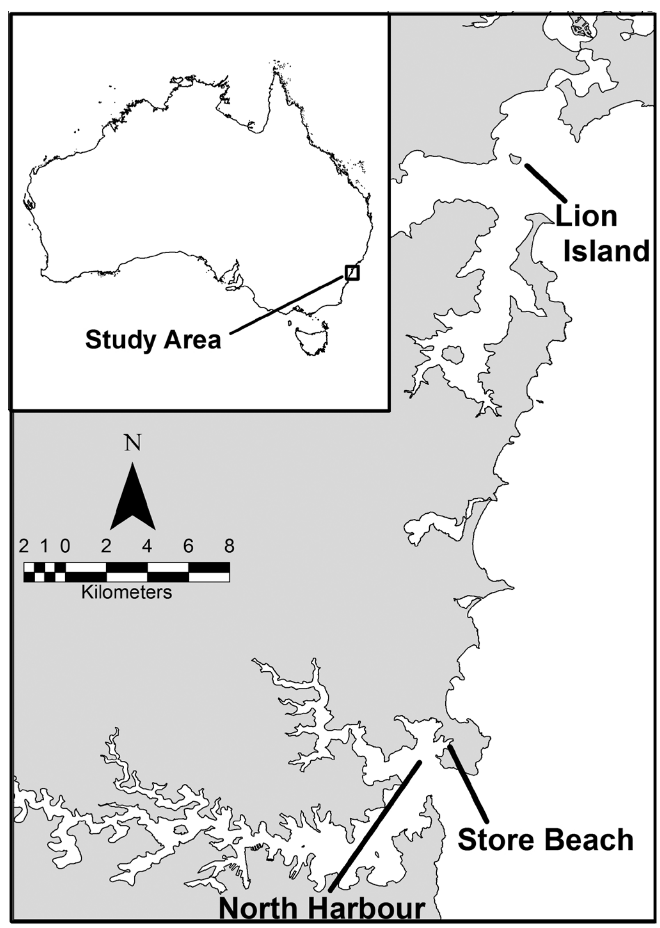

Fig. 1. Map of the location of Store Beach within North Harbour, Sydney, Australia and the donor colony at Lion Island (shaded area is land; white area is sea).

by road. Captive-bred fledglings from Taronga Zoo travelled for 45 minutes, 12 km by road. Captive-bred fledglings from Sydney Aquarium were transported for 1 hour, 18 km by road. At Store Beach all fledglings were placed in nest boxes, either singly or with their sibling.

Once the birds were installed, the exit from the nest box was blocked and the birds were left unattended overnight, as recommended by Numata (1997). The following day, shortly before sunset, the blockage was removed, leaving the birds free to depart when ready. The nest boxes were inspected daily until the fledgling departed. Tracks crossing the beach confirmed each bird had gone to sea.

Fledgling mass

The fledging mass of Little Penguins can influence return rates (Dann 1988), so the following parameters of body mass were compared among the recipient and the three donor populations: the mean mass of fledglings; the mean mass of adults; and the ratio of fledgling mass to adult mass. The mass of adults on Lion Island and adults and fledglings at North Harbour were obtained from data previously collected at these locations (Rogers *et al.* 1995, Priddel *et al.* 2008).

Post-translocation monitoring

The North Harbour colony was monitored weekly during the 2005/06 breeding season and fortnightly during seasons 2006/07 to 2013/14. Only accessible sites were visited, accounting for approximately 75% of all breeding pairs. Nests were inspected throughout the breeding season (July to January inclusive) and nest contents recorded during each visit. Any evidence of penguin nesting activity was investigated, as were tracks leading from the beach. Where adults were detected and within reach, their identity was determined by scanning for the presence of a microchip. Some burrows and cavities were too deep or convoluted for birds to be reached, so not all birds could be identified.

RESULTS

Translocation of penguins

Lion Island was visited on 13 occasions from 2004/05 to 2006/07 to find a total of 44 Little Penguin fledglings (mass: 820–1 320 g) suitable for translocation, from 25 nests. In that time, Taronga Zoo provided 14 fledglings (mass: 820–1 090 g) for translocation and Sydney Aquarium five fledglings (mass: 920–1 250 g). Over the three seasons, 19, 21 and 23 birds, respectively, were translocated to Store Beach. In 2006/07 a single bird departed 24 hours prematurely when the nest box was illegally disturbed and the temporary blockage removed; this bird was not seen again. Otherwise, all other birds left the nest box within 24 hours of unblocking the entrance.

Fledgling mass

The mass of fledglings and adults from each Little Penguin population, along with the ratio of fledgling to adult mass, is shown in Table 1. Fledglings and adults from Lion Island were of similar mass, to those from the North Harbour colony. Fledglings from Sydney Aquarium were of similar mass to those from Lion Island (two-tailed t-test assuming unequal variance: $t = 0.508$, df = 5, $P = 0.633$) but those from Taronga Zoo weighed significantly less (11%) than their wild counterparts ($t = 3.639$, df = 28, $P = 0.001$). Both wild colonies (Lion Island and North Harbour) had a higher fledgling-to-adult mass ratio than either of the two captive colonies (Table 1).

Returning penguins

From 2004/05 to 2006/07, a total of 63 Little Penguin fledglings were translocated to Store Beach, and the total North Harbour colony fledged at least 327 chicks, of which 113 were implanted with microchips. In all, 12 locally wild-bred birds and three translocated wild-bred birds are known to have returned to the North Harbour colony (Table 2), although none were detected in 2005/06, 2012/13 or 2013/14. One of the three translocated returnees had fledged heavier (1 200 g) than the mean mass of translocated fledglings (1 049 SE 123 g, n = 44) but two had fledged lighter (910 g and 950 g). None of the captive-bred translocated birds were ever detected.

Overall, the return rate for translocated wild-bred birds was less than half that of locally wild-bred birds (5% compared to 11%, Table 3). Return rates for locally wild-bred and translocated wild-bred birds were similar for the 2004/05 and 2006/07 cohorts, but not for the 2005/06 cohort, for which 20% of locally wild-bred birds returned, but no translocated wild-bred birds (Table 3). Three of the five locally wild-bred returnees from the 2005/06 cohort

TABLE 1
Mass of Little Penguin fledglings and adults from wild-bred (North Harbour and Lion Island) and captive-bred (Taronga Zoo and Sydney Aquarium) populations

Colony	Age	Mass (g)			n	Fledging mass/ adult mass	Source
		Mean	SD	Range			
Lion Island	Fledgling	1 049	123	820–1 320	44	1.01	This study
Lion Island	Adult	1 043	155	–	500		Rogers *et al*. (1995)
Sydney Aquarium	Fledgling	1 082	139	920–1 250	5	0.95	This study
Sydney Aquarium	Adult	1 141	67	1 030–1 230	6		This study
Taronga Zoo	Fledgling	934	95	820–1 090	14	0.94	This study
Taronga Zoo	Adult	993	129	850–1 400	25		This study
North Harbour	Fledgling	1 059	–	–	106	1.03	Priddel *et al*. (2008)
North Harbour	Adult	1 027	–	–	201		Priddel *et al*. (2008)

failed to breed (Table 3). Thus, the overall return rate of breeders (the percentage of fledglings that returned to breed) was only marginally greater for locally wild-bred birds (7% compared to 5% for translocated wild-bred birds, Table 3).

Returning birds were first recorded at the North Harbour colony between one and five years after fledging. Eight of the locally wild-bred returnees and all three of the translocated wild-bred returnees went onto breed themselves. One translocated wild-bred bird returned to Store Beach, the other two to headlands either side of the beach, 245 m and 285 m from the release site.

Population size

Between 2004/05 and 2013/14 the size of the Little Penguin population at North Harbour changed little, maintaining approximately 60 pairs, although the distribution of nest sites along the foreshore has changed. For example, the number of pairs breeding at Store Beach has increased from one to nine pairs, with nesting occurring in both natural nest sites (n = 6) and artificial nest boxes (n = 4) including one pair's second brood using a different nest site.

DISCUSSION

Breeding productivity of the Little Penguin colony on Lion Island (300 pairs) is approximately 1.4 fledglings per pair (Rogers *et al.* 1995). Thus, the removal of 44 fledglings over 3 years reduced the total reproductive output of the colony during this period by approximately 3.6%. The effect on the donor colony of this temporarily low level of output is unknown, but given the high productivity of this particular colony (Priddel *et al.* 2008), any impact is likely to be minimal.

TABLE 2
Translocated and locally wild-bred fledglings detected in the North Harbour colony between 2006/07 and 2011/12 and their breeding status

Idenfication code[a]	Origin	Cohort	Breeding season					
			2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
012FF9ET	North Harbour	2004/05	Breeding					
01A7409T	North Harbour	2004/05	Breeding					
00128723T	Lion Island	2004/05		Breeding	Breeding			
1DB5B7DT	North Harbour	2004/05		Breeding				
019A8A8T	North Harbour	2004/05		Non-breeding				
66FED71T	North Harbour	2005/06	Non-breeding					
01122A6T	North Harbour	2005/06		Non-breeding	Breeding	Breeding	Non-breeding	
66D6C42T	North Harbour	2005/06		Non-breeding				
66FED71T	North Harbour	2005/06			Breeding	Breeding		
66FF000T	North Harbour	2005/06					Non-breeding	
6831702T	Lion Island	2006/07			Breeding			
6833BB5T	Lion Island	2006/07				Breeding	Breeding	Breeding
683154BT	North Harbour	2006/07				Breeding	Breeding	
67B8C8FT	North Harbour	2006/07				Breeding		
682F946T	North Harbour	2006/07						Breeding

NOTE: No captive-bred translocated penguins were detected. No target birds were detected in 2005/06 or 2012/13.
[a] Identifies individuals.

TABLE 3
Microchipped locally wild-bred fledglings from the North Harbour colony, fledglings translocated into the colony, and birds returning and breeding

Cohort	Number (%)					
	Fledglings		Returned birds		Returned birds found breeding	
	Locally wild-bred	Translocated	Locally wild-bred	Translocated	Locally wild-bred	Translocated
2004/05	56	19	4 (7)	1 (5)	3 (5)	1 (5)
2005/06	25	21	5 (20)	0 (0)	2 (8)	0 (0)
2006/07	32	23	3 (9)	2 (9)	3 (9)	2 (9)
Total	113	63	12 (11)	3 (5)	8 (7)	3 (5)

The number of fledglings harvested from Lion Island was lower than anticipated, owing largely to the difficulty of locating birds of precisely the correct age for translocation, a challenge exacerbated by the small size of the colony, the patchy and poorly known distribution of nest sites, and the difficulty of access. In New Zealand, similar translocations targeted an easily accessible donor colony of approximately 5 000 pairs (Challies pers. comm.). Consequently, finding birds of appropriate age was much easier, with up to 46 fledglings translocated per visit (Gummer 2003). Future translocations of penguins to Store Beach, or other depleted NSW colonies, could be conducted more efficiently by obtaining numerous wild-bred fledglings from a large donor colony such as the one on Montague Island, Narooma (36°15′S, 150°14′E), where approximately 5 000 pairs breed (Weerheim *et al.* 2003). The Little Penguin has been shown to move between colonies along the eastern Australian coastline (Priddel *et al.* 2008), so the transfer of genetic material between colonies already occurs naturally. Expeditious transfer of birds between distant colonies could be ensured by utilising a helicopter, as has been done for several translocations of seabirds in New Zealand (Bell pers. comm.).

Any translocation should not diminish the survival rate of the individuals involved. A previous eight-year study of the North Harbour colony involving a large number of banded individuals found that up to 15% of fledglings returned to the colony and 8%–11% bred (Priddel *et al.* 2008). Return rates for the 113 locally wild-bred birds from the North Harbour colony during this study were lower: 11% returning and 7% breeding. The return rate of translocated wild-bred birds was 5% returning and 5% breeding. These results suggest that translocated wild-bred birds may have a lower survival rate than non-translocated birds, at least in some years (e.g. 2005/06). However, sample sizes in this study are insufficient to give statistical significance to such a conclusion. Also, imprinting on the natal colony may occur well before fledging; consequently, translocated birds may simply have returned to their original colony. We undertook no monitoring on Lion Island; so we do not know whether any translocated wild-bred birds returned there. Additionally, transponder failure or loss may also have contributed to the low return rates observed in both translocated and non-translocated birds. Dann *et al.* (2014) reported a transponder failure rate of ~5% in the first year of implantation in free-living Little Penguins, with a gradual further reduction of ~1% over time. Reported loss rates in penguins are typically 1%–4% (Hindell *et al.* 1996, Clarke & Kerry 1998, Gauthier–Clerc *et al.* 2004, Dann *et al.* 2014), but losses of up to 30% have been observed (Clarke & Kerry 1998).

Based on the return rate of locally wild-bred birds, it was expected that five translocated wild-bred birds and two captive-bred birds would return; and of these translocated birds, three wild-bred birds and one captive-bred bird would have gone on to breed. While the number of returning translocated wild-bred birds was close to expected (3 returned, 3 bred), no captive-bred birds have been detected at the colony. Despite the low numbers of captive-bred returnees expected, the absence of any record of a captive-bred bird having returned to North Harbour is of concern, and may signify that such birds are unsuitable for release into the wild. Although the captive-bred birds used in this study were raised by their parents and seldom handled, they may have been affected by their interactions with humans and they may not have behaved naturally in the wild, although evidence from other species suggests otherwise. For example, the return rate of hand-reared African Penguin chicks was similar to that of naturally reared chicks (Barham *et al.* 2008).

More likely, the apparent low rate of survival of the Taronga birds after release was due, at least in part, to their comparatively low fledging mass. Fledglings from Sydney Aquarium were heavier than wild birds, but those from Taronga Zoo were much lighter (Table 1). Although not evident in this study, other studies with larger sample sizes have demonstrated that survival of young penguins is dependent on their mass at the time of fledging. For wild-bred Little Penguins on Phillip Island, Victoria, the highest return rates were for fledglings of mass 1 050–1 300 g (Dann 1988). The comparatively high survival rate (≥16%) of 1 787 African Penguin fledglings one year after their release from care was due, in part, to their mass on release being above average for this species (Barham *et al.* 2008). If future translocations of captive-bred Little Penguins are attempted, a higher minimum mass requirement than that used in this study may improve their post-fledging survival and their likelihood of returning.

Although the penguin population at North Harbour has changed little since 2004, the number of pairs nesting on Store Beach has increased substantially, from one to nine pairs. Store Beach is a relatively secure breeding site for Little Penguins in Sydney Harbour and, being part of a national park, is more easily managed for conservation purposes than urban areas of the colony. Aggregating the existing penguin population to Store Beach is a key objective of the recovery program and has been encouraged by a suite of management actions implemented to enhance the habitat and level of protection at this particular site. Although two of the three translocated birds that returned to Store Beach actually returned to headlands either side of the beach, these sites are within Sydney Harbour National Park and inside the area intensively managed for Little Penguins.

Rafting Little Penguins congregate at sea and come ashore en masse at sunset (Berlincourt & Arnould 2014), following the leaders ashore. Consequently, the presence of nesting birds at Store Beach is likely to have drawn others to the site. Experience with other seabird species has demonstrated that establishment of new colonies can be achieved by the translocation of very few founding individuals (Carlile *et al.* 2012) or by the use of acoustic attractants only (Miskelly *et al.* 2009). The use of acoustic devices is impractical at Store Beach because of a daily public presence, resulting in a high likelihood of theft or vandalism of any installed instruments.

Despite the controls now in place, the potential for disturbance at most urban nesting sites within the North Harbour colony is high and intensifying as the density of the local human population increases. The effect of this persistent and ongoing pressure appears to be encouraging the birds to seek alternative nesting sites free from disturbance. Disturbance at Store Beach is relatively low, due to a program of sustained predator control and regular patrols by officers of government marine and terrestrial conservation agencies. Thus, we expect the expanding colony at Store Beach to continue to attract penguins prospecting for nest sites, further enlarging the population nesting at this site. Over time, it is hoped that Store Beach will become the breeding stronghold for the Little Penguin in Sydney Harbour. If this does not occur, or if the population declines significantly, reinforcement (augmentation) of the population through the translocation of fledglings from Montague Island is feasible and should be considered. Translocating fledglings within the colony, from other sites in North Harbour to Store Beach, has been considered but was deemed to be both logistically challenging and politically unacceptable.

CONCLUSIONS

For the first time, techniques developed for the translocation of wild-bred and captive-bred Little Penguins have been documented and evaluated. Although only low numbers of translocated wild-bred birds returned to the North Harbour colony, the proportion of birds that returned and bred was comparable to that of locally wild-bred fledglings. Extending the annual monitoring to include the penguins' moult period (February to March) may have increased the number of returning birds detected.

Using a greater number of fledglings from a larger donor colony could increase the effectiveness of any future translocation and hasten the establishment of a sizeable breeding colony. Also, intensive monitoring of donor colonies from which wild-bred birds are removed (e.g. Priddel *et al.* 2006, Miskelly *et al.* 2009, Carlile *et al.* 2012) would detect the percentage of fledglings returning to their natal sites and verify, or otherwise, the effectiveness of the translocation technique. The potential for reinforcing colonies by releasing fledgling Little Penguins from captive facilities has yet to be demonstrated. Preliminary studies should be undertaken to confirm that captive-bred penguins are capable of surviving in the wild. If further translocations of captive-bred fledglings are undertaken, those birds released should be of similar or greater mass than their wild-bred counterparts.

ACKNOWLEDGMENTS

Chris Challies kindly shared his knowledge of penguin translocation procedures, without which this project may not have commenced. The translocation of captive-bred Little Penguins was made possible through the participation and dedication of staff from Taronga Zoo and Sydney Aquarium, and the cooperation of staff from North Head and Lower Hawkesbury areas of the NSW National Parks and Wildlife Service. This work, along with the subsequent monitoring, was supported by the Sydney Harbour Little Penguin Recovery Team and the Metropolitan Aboriginal Land Council. Tania Duratovic, Terry O'Dwyer, Geoff Smith and others provided voluntary assistance in the field. David Ruckert (Australian Institute of Police Management) coordinated access to police lands. The residents of Manly Point kindly provided access to penguin nests located on their land for post translocation monitoring. The study was conducted according to the translocation policy of the NSW Office of Environment and Heritage, and under Scientific Licences S10614 and S10615, and Animal Ethics Committee approval No. 021028/02.

REFERENCES

BARHAM, P.J., CRAWFORD, R.J.M., UNDERHILL, L.G., WOLFAARDT, A.C., BARHAM, B.J., LESHORO, T.M., MEYER, M.A., NAVARRO, R.A., OSCHADLEUS, D., UPFOLD, L., WHITTINGTON, P.A. & WILLIAMS, A.J. 2006. Return to Robben Island of African Penguins that were rehabilitated, relocated or reared in captivity following the Treasure oil spill of 2000. *Ostrich* 77: 202–209.

BARHAM, P.J., UNDERHILL, L.G., CRAWFORD, R.J.M., ALTWEGG, R., MARIO LESHORO, T., BOLTON, D.A., DYER, B.M. & UPFOLD, L. 2008. The efficacy of hand-rearing penguin chicks: evidence from African Penguins (*Spheniscus demersus*) orphaned in the Treasure oil spill in 2000. *Bird Conservation International* 18: 144–152.

BARTON, D. 1978. Breeding Fairy Penguins at Twofold Bay, N.S.W. *Corella* 2: 71–72.

BELL, M., BELL, B.D. & BELL, E.A. 2005. Translocation of fluttering shearwater (*Puffinus gavia*) chicks to create a new colony. *Notornis* 52: 11–15.

BERLINCOURT, M. & ARNOULD, J.P.Y. 2014. At-sea associations in foraging Little Penguins. *PLoS ONE* 9: e105065.

BOURNE, J. & KLOMP, N.I. 2003. Ecology and management of the Little Penguin *Eudyptula minor* in Sydney Harbour. In: Lunney, D. & Burgin, S. (Eds). Urban Wildlife: more than meets the eye. Mosman: Royal Zoological Society of New South Wales. pp. 131–137.

CARLILE, N., PRIDDEL, D. & MADEIROS, J. 2012. Establishment of a new, secure colony of Endangered Bermuda Petrel *Pterodroma cahow* by translocation of near-fledged nestlings. *Bird Conservation International* 22: 46–58.

CLARKE, J. & KERRY, K. 1998. Implanted Transponders in Penguins: Implantation, Reliability, and Long-Term Effects (Transpondores Implantados en Pinguinos: Implantación, Confiabilidad, y Efectos a Largo Plazo). *Journal of Field Ornithology* 69: 149–159.

DANN, P. 1988. An experimental manipulation of clutch size in the Little Penguin *Eudyptula minor*. *Emu* 88: 101–103.

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. & CULLEN, J.M. 1990. Survival, patterns of reproduction, and lifetime reproductive output in Little Blue Penguins (*Eudyptula minor*) on Phillip Island, Victoria, Australia. In Davis, L.S. & Darby, J.T. (Eds). Penguin Biology. San Diego: Academic Press. pp. 63–84.

DANN, P., SIDHU, L.A., JESSOP, R., RENWICK, L., HEALY, M., DETTMANN, B., BAKER, B. & CATCHPOLE, E.A. 2014. Effects of flipper bands and injected transponders on the survival of adult Little Penguins *Eudyptula minor*. *Ibis* 156: 73–83.

FORTESCUE, M.E. 1995. Biology of the Little Penguin *Eudyptula minor* on Bowen Island and at other Australian colonies. In: Dann, P., Norman, I. & Reilly, P. (Eds). The Penguins. Moorebank: Surrey Beatty & Sons. pp. 364–392.

GAUTHIER–CLERC, M., GENDNER, J.P., RIBIC, C.A., FRASER, W.R., WOEHLER, E.J., DESCAMPS, S., GILLY, C., LE BOHEC, C. & LE MAHO, Y. 2004. Long–term effects of flipper bands on penguins. *Proceedings of the Royal Society of London B: Biological Sciences* 271: S423–S426.

GUMMER, H. 2003. Chick translocation as a method of establishing new surface-nesting seabird colonies: a review. DOC Science Internal Series 150. Wellington: Department of Conservation.

HARRIGAN, K.E. 1992. Causes of mortality of Little Penguins *Eudyptula minor* in Victoria. *Emu* 91: 273–277.

HINDELL, M.A., LEA, M.-A. & HULL, C.L. 1996. The effects of flipper bands on adult survival rate and reproduction in the Royal Penguin, *Eudyptes schlegeli*. *Ibis* 138: 557–560.

HOUSTON, D.M. 1999. The use of nest boxes for blue penguins (*Eudyptula minor*). Ecological Management 7. Wellington, New Zealand: Department of Conservation. pp. 7–11.

HULL, C.L., HINDELL, M.A., GALES, R.P., MEGGS, R.A., MOYLE, D.I. & BROTHERS, N.P. 1998. The efficacy of translocating little penguins *Eudyptula minor* during an oil spill. *Biological Conservation* 86: 393–400.

IUCN 2014. The IUCN Red List of Threatened Species, Version 2014.3. [Available online at: http://www.iucnredlist.org; accessed 22 June 2014].

KRESS, S.W. & NETTLESHIP, D.N. 1988. Re-establishment of Atlantic puffins (*Fratercula artica*) at a former breeding site in the Gulf of Maine. *Journal of Field Ornithology* 59: 161–170.

LANE, S.D. 1979. Seabird islands, Lion Island, New South Wales. *The Australian Bird Bander* 13: 34–37.

MARCHANT, S. & HIGGINS, P.J. 1990. Handbook of Australian, New Zealand and Antarctic Birds. Volume 1: ratites to ducks. Melbourne: Oxford University Press.

MISKELLY, C.M., TAYLOR, G.A., GUMMER, H. & WILLIAMS, R. 2009. Translocations of eight species of burrow-nesting seabirds (genera *Pterodroma, Pelecanoides, Pachyptila* and *Puffinus*: Family Procellariidae). *Biological Conservation* 142: 1965–1980.

NORMAN, F.I., CULLEN, J.M. & DANN, P. 1992. Little penguins *Eudyptula minor* in Victoria — past, present and future. *Emu* 91: 402–408.

NUMATA, M. 1997. Effects of philopatry on the outcome of translocating endangered seabirds. Wildlife Management Report: 92. Dunedin, Australia: University of Otago.

PEUCKER, P.J., DANN, P. & BURRIDGE, C.P. 2009. Range-wide phylogeography of the Little Penguin (*Eudyptula minor*): Evidence of long-distance dispersal. *The Auk* 126: 397–408.

PRIDDEL, D. & CARLILE, N. 1995. An artificial nest box for burrow-nesting seabirds. *Emu* 95: 290-294.

PRIDDEL, D., CARLILE, N. & WHEELER, R. 2006. Establishment of a new breeding colony of Gould's petrel (*Pterodroma leucoptera leucoptera*) through the creation of artificial nesting habitat and the translocation of nestlings. *Biological Conservation* 128: 553–563.

PRIDDEL, D., CARLILE, N. & WHEELER, R. 2008. Population size, breeding success and provenance of a mainland colony of Little Penguins (*Eudyptula minor*). *Emu* 108: 35–41.

REILLY, P.N. & BALMFORD, P. 1975. A breeding study of the Little Penguin *Eudyptula minor* in Australia. In: Stonehouse, B. (Ed.) The biology of Penguins. London, UK: MacMillan. pp. 161–187.

REILLY, P.N. & CULLEN, J.M. 1979. The Little Penguin *Eudyptula minor* in Victoria, I: mortality of adults. *Emu* 79: 97–102.

REILLY, P.N. & CULLEN, J.M. 1981. The Little Penguin *Eudyptula minor* in Victoria, II: breeding. *Emu* 81: 1–19.

ROGERS, T., ELDERSHAW, G. & WALRAVEN, E. 1995. Reproductive success of Little Penguins, *Eudyptula minor*, on Lion Island, New South Wales. *Wildlife Research* 22: 709–715.

SERVENTY, D.L., GUNN, B.M., SKIRA, I.J., BRADLEY, J.S. & WOOLLER, R.D. 1989. Fledgling translocation and philopatry in a seabird. *Oecologia* 81: 428–429.

STAHEL, C. & GALES, R. 1987. Little Penguin: Fairy Penguins in Australia. Kensington: NSW University Press.

WEERHEIM, M.S., KLOMP, N.I., BRUNSTING, A.M.H. & KOMDEUR, J. 2003. Population size, breeding habitat and nest site distribution of little penguins (*Eudyptula minor*) on Montague Island, New South Wales. *Wildlife Research* 30: 151–157.