Corella, 2018, 42: 80-85

Movement of Short-tailed Shearwaters *Ardenna tenuirostris* banded at Phillip Island, Victoria from 1956 to 2010

D. B. Boyle[1], B. K. Goyen[2], D. G. Cameron[3] and R. G. Cameron[4]

[1]6 Mary Place, Leopold, Victoria 3224.
Email: davidboyle48@gmail.com
[2]6 Myrtle Court, East Doncaster, Victoria 3109.
[3]8 Ida Court, Donvale, Victoria 3111.
[4]82 Balnarring Road, Merricks North, Victoria 3926.

Received: 19 March 2018
Accepted: 12 June 2018

Between February 1956 and April 2010, 36 127 adult and nestling Short-tailed Shearwaters, *Ardenna tenuirostris* were banded at Phillip Island, Victoria, 90.6% at the Cape Woolamai breeding colony. From 1956 to 1974, mostly nestlings were banded (83% of 22 976 individuals), whilst from 1979 to 2010 more bands were applied to adults (59.5% of 13 151). One thousand one hundred and seventy-eight of these bands were retrieved as recoveries (i.e. from birds found dead) or retraps (from birds re-trapped alive). Fourteen recoveries were from the northern Pacific Ocean between 1962 and 1997 (May-August) and three were from the western shores of North Island, New Zealand (October and November). One hundred and nine recoveries were from the Australian coast (>10 km from the banding site). Four retraps and one recovery were at shearwater breeding colonies quite distant from Cape Woolamai. The longest elapsed time (39.9 years) between banding and recovery or re-trapping was for an individual banded at Cape Woolamai (March 1961) and recovered at Cape Duquesne, Discovery Bay Coastal Park, Victoria (February 2001). All other retraps and recoveries occurred within 27 years of banding. The highest rate of recoveries occurred within the first year post-banding for nestlings (45%, 58 of 128); thereafter the recovery rates of banded nestlings and adults were similar. Retraps at the banding site showed that individuals banded as nestlings enter the breeding colony at 5 to 6 years of age.

INTRODUCTION

The Short-tailed Shearwater (STSW), *Ardenna tenuirostris* is perhaps Australia's most abundant seabird, with an estimated population of 20 to 30 million (Skira 1991). It is the only petrel breeding solely in Australia. Breeding occurs in burrows during the austral summer on offshore islands around south-eastern Australia. Post-breeding adults and fledglings undertake a trans-equatorial migration, spending the austral winter in the northern Pacific Ocean and returning to their Australian breeding colonies by late September-early October (Skira 1991). More than 120 000 STSW have been uniquely banded at Australian colonies (Australian Bird and Bat Banding Schemes, ABBBS). Of these, one quarter were banded at Phillip Island, Victoria, mostly at Cape Woolamai (145.25º E, 38.47º S) (Norman and Gottsch 1969; The 1971; Sedon 1975; Harris and Bode 1981).

Short-tailed Shearwaters were exploited by indigenous Australians and European settlers for eggs, meat and oil (Marchant and Higgins 1990; Skira 1991). Harvesting of nestlings and eggs at Cape Woolamai ceased in 1924 and STSW are now fully protected in Victoria. Cape Woolamai was proclaimed a faunal reserve in 1964. The mystery of where STSW went in the austral winter prompted the first bird banding operation in Australia, which was conducted by members of the Bird Observers Club in April 1912 at Cape Woolamai (Gottsch 1966). With the commencement of the CSIRO Bird Banding Scheme in 1953, large scale banding of STSW commenced at Phillip Island and other colonies. Recoveries were made in the northern Pacific Ocean, confirming migration to the northern hemisphere during the austral winter (Skira 1991).

Here we have conducted an analysis of all recoveries (birds found dead) and retraps (birds re-trapped alive) of STSW banded at Phillip Island between 1956 and 2010. Our aims were to: (1) document the scale of movement revealed by the recoveries and retraps, (2) analyse the age structure of the Phillip Island population, and (3) document age at first breeding and mortality patterns.

METHOD

Study area

Phillip Island is located ~100 km southeast of Melbourne, Victoria, with Cape Woolamai at its south-eastern end. The Cape Woolamai colony, covering an estimated 132 ha and containing ~356 200 burrows, accounted for ~66% of the STSW burrows on Phillip Island. In 1978 an estimated 82% of burrows visibly active in October contained eggs in December (Harris and Bode 1981). This provided a population estimate of ~600 000 breeding birds, similar to an estimate made in 1967 (Norman and Gottsch 1969).

Banding

Before 1976, numbered, flat, monel strips were shaped in the field into bands to fit the STSW leg. These were replaced after 1976 by size 16 ABBS bands, which were made of stainless steel and egg-shaped, designed specifically for the laterally compressed legs of STSW. Data from both types of bands were combined in our analyses. From late September to early November, adult STSW were captured by hand on the ground or in burrows shortly after sunset when they were returning to the colony. Nestlings were banded from late March to mid-April,

being caught in their burrow during the day shortly before they were expected to fledge and returned to it immediately after banding.

Banding commenced in 1956 and continued regularly until 1974 when it was discontinued. It recommenced in 1979 and continued until 2010. Between 1979 and 2010, banding was undertaken on the western edge of Cape Woolamai from the cliff edge to 150 m east and north of 38.5523º S, 145.3467º E (~2.5 ha). From 1956 to 1972, banding was undertaken in the same general location, although over a much greater area. Banding was also conducted elsewhere on Phillip Island from 1956 to 1974; however, in older records the exact locations are difficult to determine.

Recoveries and retraps

The ABBBS database was searched in November 2015 for all banding records and retraps and recoveries of STSW banded at Phillip Island. After inspection (with the assistance of ABBBS), a small number of unsatisfactory records were excluded from our analyses. The ABBBS records provided: date banded, recovery site (longitude and latitude), recovery method (e.g. found dead, beach washed etc.), status (alive or dead), distance (km) and direction moved from the banding site, months elapsed from banding to recovery or re-trapping and name of the bander. For the analyses, ages at banding were consolidated into two groups, i.e. nestlings (chicks captured in burrows, described as nestlings and/or juveniles) and adults (descriptions used were first year, first year or older, third year or older, fourth year or older, fifth year and fifth year or older). For approximately 3% of records the age at banding was unknown; these were arbitrarily included as adults in analyses.

Recruitment age, mortality rates and longevity

The elapsed time from banding to re-trapping was used to analyse recruitment of STSW banded as nestlings (86 retraps at Cape Woolamai, 2 at other colonies) to breeding colonies and to compare this with the return to the colony of STSW banded as adults (687 unique retraps >10 days post-banding; 685 at Cape Woolamai, 2 at other colonies). Where STSW were re-trapped on multiple occasions, only the last re-trapping was included in the analysis. Retraps were categorised into year groupings i.e. 0 to < 1 year, 1 to < 2 years etc., and a cumulative percentage re-trapping rate for each year was calculated and plotted against the year grouping. To examine age structure and mortality rates of STSW banded as nestlings (128 at, or distant from the banding site at ≥ 8 days) and adults (63 at >60 days all locations), a similar analysis was undertaken on all recoveries.

RESULTS

Scale of banding

Between February 1956 and April 2010, 36 127 adult and nestling STSW were banded, 90.6% at Cape Woolamai. A further 3375 (9.3%) were banded at other Phillip Island colonies. From 1956 to 1974, the focus was on the banding of nestlings (83% of 22 976 birds), but from 1979 to 2010 more bands were applied to adults (59.5% of 13 151). Most banding (67.9%) was done in March-April on nestlings and in October (17.2%) on adults. In total, 24 409 (67.6%) bands were applied to nestlings and 11 718 (32.4%) to adults.

Recoveries in the northern hemisphere and New Zealand

Fourteen recoveries were made in the northern Pacific Ocean between 1962 and 1997 (Fig. 1a; Appendix 1). The most frequent method of recovery was "trapped because bird tangled in fishing gear" (10 recoveries). Eleven (78.6%) of the 14 recoveries were from birds banded as nestlings. The distance of the recovery from the banding site was 7 888 to 12 163 km. The time elapsed from banding to recovery ranged from 51 (nestling banded March 1961 recovered May 1961) to 5917 days (i.e. 16.3 years – nestling banded March 1961 and recovered June 1977). Seven of the 14 recoveries (between May and July) were within 102 days of banding (range 51-102). These were from nestlings banded in March and April in the year in which they were recovered (Appendix 1). Northern hemisphere recoveries were made between May and August. The distance between the banding and the recovery site increased from May to August, suggesting movement of birds from the north-western to the north-eastern Pacific Ocean as the northern hemisphere summer progressed (Fig. 1a, Appendix 1).

Three recoveries (one banded as a nestling, two as adults) were made in New Zealand from "beach-washed birds" in October and November on the west coast of the North Island. Notably, one recovery was from a nestling banded in April 1997 and recovered in October 2013 (16.6 years) (Fig. 1b, Appendix 1).

Retraps and recoveries in Australia away from the banding site

One hundred and nine recoveries were made on the Australian coast > 10 km from the banding sites (Fig. 1b). Of these, 65.7% were from birds banded as nestlings (67.6% 24 409 bands applied to nestlings). "Beach-washed" (101/105) was the most frequently reported method of recovery. Most recoveries (77.1%) were made between October and January in the eastern and south-eastern states (Queensland 5, New South Wales 45, Australian Capital Territory 1 [Jervis Bay], Victoria 52, South Australia 4 and Tasmania 2). The most northerly recovery was at Tannum Beach near Gladstone, Queensland (151.33º E 23.83º S), the most southerly at Reidle Bay, Maria Island, Tasmania (148.08º E 42.68º S) and the most westerly at Waitpinga Beach, South Australia (138.48º E 35.63º S).

Four retraps and one recovery were made at other shearwater breeding colonies. For these, distance from the banding site was 17 to 1163 km and elapsed times 1.6 to 7.6 years. The retraps were at colonies along the New South Wales coast (Mutton Bird and Montague Islands) and in Victoria (Tankerton Hill, French Island and Swan Lake, Phillip Island). One recovery was made at the breeding colony at Griffith Island, Victoria (Appendix 2).

The longest elapsed time (39.9 years) was for a STSW of unknown age banded at Cape Woolamai (March 1961) and recovered at Cape Duquesne, south-east end of Discovery Bay Coastal Park, Victoria (February 2001).

Recruitment age, mortality rates and longevity

No retraps of STSW banded as nestlings were made in the first year after banding; thereafter a small number were made in years 2 to 4 post-banding. By years 5 and 6 post-banding, more STSW banded as nestlings were recaptured in the natal

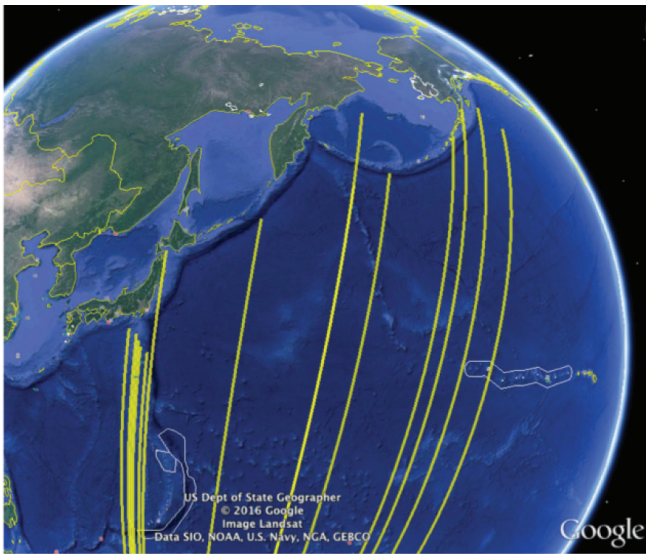

Figure 1a. *Locations of recoveries in the northern Pacific Ocean of Short-tailed Shearwaters banded at Cape Woolamai, Phillip Island.* (Google Earth)

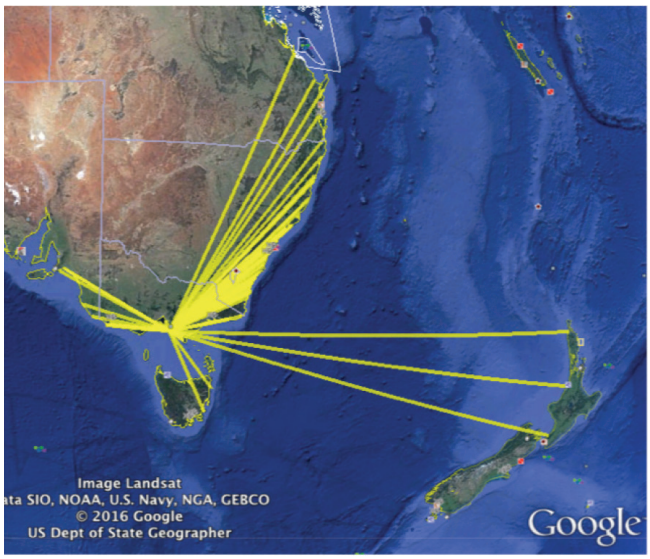

Figure 1b. *Locations of recoveries and retraps in Australia and New Zealand of Short-tailed Shearwaters away from the banding site, Cape Woolamai, Phillip Island.* (Google Earth)

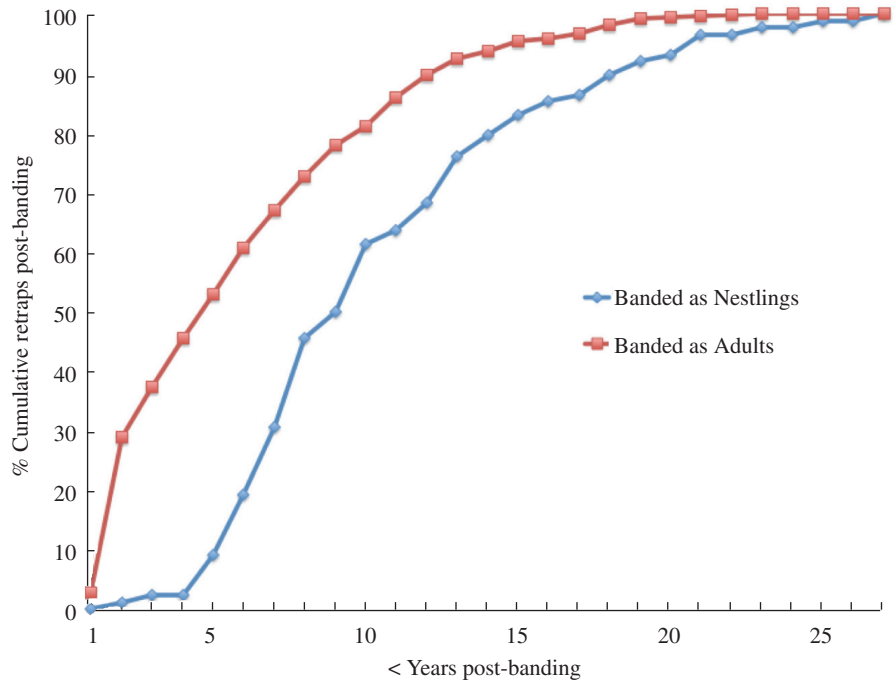

Figure 2. *Cumulative percentage retraps of banded nestling (88) and adult (687) Short-tailed Shearwaters by year of retrap.*

colony (Fig. 2). Fifty percent of the re-trapping of birds banded as nestlings had occurred by year 9 and 100% by year 27. For STSW banded as adults, 50% of retraps occurred by year 5 and 100% by year 22 post-banding (Fig. 2).

For STSW banded as nestlings, 58 of 128 recoveries (45.3%) were made within one year of banding. These were not included in the cumulative recovery analysis. A comparison of recoveries of STSW banded as nestlings (70) with those banded as adults (63, Fig. 3) showed no apparent difference in the cumulative rate of recoveries since banding i.e. after the high first-year mortality of nestlings, the implied mortality rate for birds banded as nestling and adults was similar. By year 7 post-banding, 50% of recoveries had been made for STSW banded as nestlings or adults and by years 23 (nestlings) or 24 (adults) all but one of the recoveries had been made (the exception being one recovered at 39.9 years; Fig. 3).

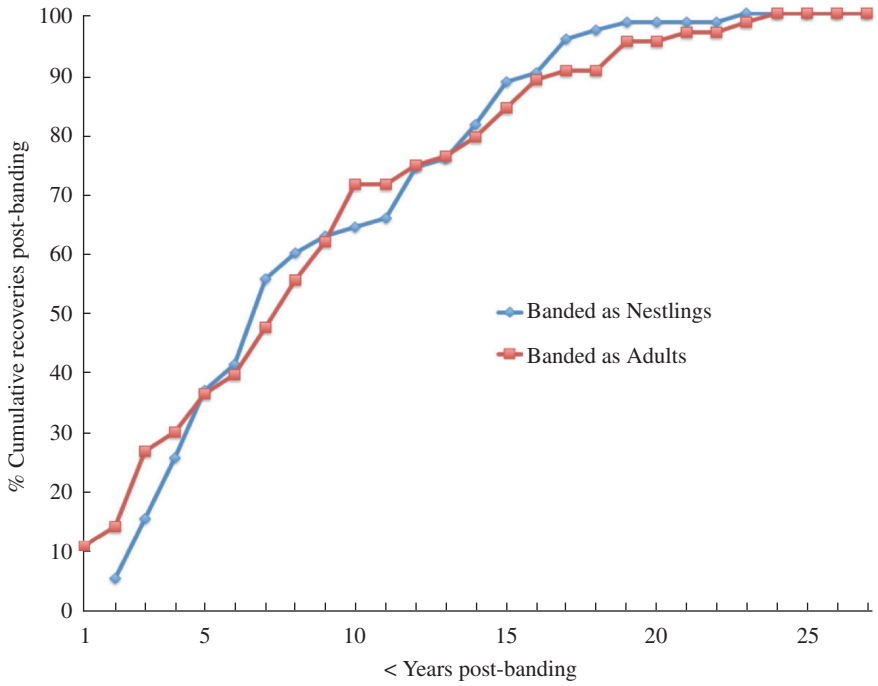

Figure 3. *Cumulative percentage recoveries of banded nestling (70) (excluding 0 to < 1 year) and adult (63) Short-tailed Shearwaters by year of recovery.*

DISCUSSION

Solving the mystery of where STSW went during the austral winter presented a challenge for early ornithologists. It was only with the advent of banding and the recovery or re-trapping of marked individuals at locations distant from breeding colonies that the scale of the movements of these birds became apparent. This analysis of STSW banded at Phillip Island is testament to the effort required to undertake long-term (>50 years) and large-scale banding (>36 000 bands) and monitoring of bird populations. Results from these studies and those at other colonies have revealed important basic information, including the birds' migration to the northern Pacific Ocean during the austral winter and their return for the austral summer. Details of breeding activities have been revealed by detailed, long-term studies at several colonies (Serventy *et al.* 1971; Serventy and Curry 1984; Fitzherbert 1985; Montague *et al.* 1986; Bradley *et al.* 1989; Marchant and Higgins 1990; Skira 1991; Bradley *et al.* 2000).

Analysis of retraps and recoveries of STSW banded at Phillip Island adds to the evidence of migration to the northern Pacific Ocean during the austral winter. Bands recovered suggest a northward and eastward movement of STSW in the northern hemisphere as the northern summer progresses, although it is difficult to draw strong, definitive conclusions from the small number (14) of recoveries. Recoveries made on the Australian (stretching from central Queensland to Tasmania and South Australia) and New Zealand coasts, confirm the wide dispersal of STSW from Phillip Island during their northerly and southerly migrations and in the breeding season. Evidence for movement among colonies was provided by retraps and recoveries at other STSW colonies (Phillip, French and Griffith Islands, Victoria and Montague Island, New South Wales). A retrap at Mutton Bird Island, Coffs Harbour (a recognised breeding colony for Wedge-tailed Shearwaters *Ardenna pacifica*, but not STSW), suggests that STSW may attempt breeding at new locations under favourable circumstances (Marchant and Higgins 1990; Lane 1991). The retraps and recoveries reported here provide evidence for movement of birds among colonies and the potential for genetic mixing, even though the number of records is small. Inter-colony dispersal has previously been reported at a Tasmanian colony (Serventy and Curry 1984). However, no retraps or recoveries were made at Phillip Island of STSW banded elsewhere.

Short-tailed Shearwaters live at least 15-20 years, on average (Serventy 1970; Serventy and Curry 1984; Bradley *et al.* 1989; Marchant and Higgins 1990). Analysis of recoveries and retraps of STSW banded as adults and nestlings at Cape Woolamai (excluding nestlings recovered within one year of banding) showed that 50% of were made by years 5 to 7 post-banding and 100% by years 24 to 27 (except for one bird recovered after almost 40 years), which is consistent with other records (Bradley *et al.* 1989; Marchant and Higgins 1990; Skira 1991). That 45% of recoveries of nestlings occurred within a year of banding demonstrated a high mortality rate in the first year of life (Serventy and Curry 1984). However, the cumulative recovery rates for birds banded as adults or nestlings were similar thereafter, suggesting that survival was similar in the two groups after the nestlings' first year of life. A detailed analysis of a larger data set from Fisher Island showed a relatively higher mortality rate and lower breeding success in first-time breeding STSW (Bradley *et al.* 1989).

Analysis of retraps at the banding site provided details of recruitment of STSW to the breeding colony. Very few retraps (5 of 88, 5.7%) of birds banded as nestlings were made within five years, suggesting that they either did not visit breeding colonies

during this time or did so only briefly. Although twice as many nestlings than adults were banded (24 409 vs. 11 718), many more adults than nestlings (687 vs 86; 8:1) were re-trapped at the banding site. This could be attributed to the high mortality of nestlings in the first year (45%) and the wide dispersal of nestlings within the very large Cape Woolamai colony when they first start to enter it. Nonetheless a small proportion (86 from 24 409) of nestlings appeared to breed in the vicinity where they were banded (Serventy and Curry 1984).

Large-scale banding activities such as those reported here are unlikely to be repeated due to the labour involved and the development of new technologies that can track bird movements on a global scale (Phillips *et al.* 2004). The gaps in our knowledge of STSW, particularly details of movement and timing of activities at sea, will be filled by using these new technologies (Carey *et al.* 2014; Berlincourt *et al.* 2015; Berlincourt and Arnould 2015). Surveys of STSW at Phillip island in 1967 (Norman and Gottsch 1969) and 1978 (Harris and Bode 1981) showed a stable population. A survey of burrowing seabirds on islands of north-central Bass Strait (not including Phillip Island) reported an estimated decline of 35% for STSW between 1978-80 and 2008-11 (Schumann *et al.* 2014). The predominantly marine lifestyle of STSW exposes them to many threatening processes, including high ingestion rates of plastic debris, over-exploitation of shared resources by fisheries activities and climate change impacts on weather and oceanic conditions (Vlietstra and Parga 2002; Carey 2011; Chambers *et al.* 2011; Yamashita *et al.* 2011; Acampora *et al.* 2014; Cousin *et al.* 2015).

ACKNOWLEDGEMENTS

We thank David Drynan and the staff of ABBBS for supporting the project and supplying data used in the analyses described. The data were provided under the Creative Commons By Attribution (CC_BY) licence and the banders' names are recorded with the attributed number banded given in brackets: P.N. Reilly (96), A. Lill (1791), D. Foley (1864), M.J. Magrath (338), G.K. Meldrum (1), D.L. Serventy (850), F.R. Vasey (2), R.G. Cameron (8928), M.D. Gottsch (4441), F.I. Norman (15), C. Hall (2376), D.J. Noonan (1498), S.G. Lane (1), A.F. Stewart (601), A. Whitehead (2060), N.J. Favaloro (522), F.G. Pinchen (16), L. Burgess (299), J.R. Blinzler (1), J.C. Fitzherbert (2313), T.W. Pescott (30), L. O'Connor (2280), W.R. Wheeler (300), H.A. Bradley (753), N.F. Weatherill (196), W.D.F. Mackenzie (51), J.L. McKean (4012), D.F. Dorward (112) and K.G. Simpson (599). The authors acknowledge the long-term contribution by volunteers and staff of the Phillip Island Nature Park who participated in the banding activities at Phillip Island.

REFERENCES

Acampora, H., Schuyler, Q.A., Townsend, K.A. and Hardesty, B.D. (2014). Comparing plastic ingestion in juvenile and adult stranded Short-tailed Shearwaters (*Puffinus tenuirostris*) in eastern Australia. *Marine Pollution Bulletin* **78**: 63-68.

Berlincourt, M., Angel, L.P. and Arnould, J.P. (2015). Combined use of GPS and accelerometry reveals fine scale three-dimensional foraging behaviour in the Short-tailed Shearwater. *PLoS One* **10**: e0139351.

Berlincourt, M. and Arnould, J.P. (2015). Breeding Short-tailed Shearwaters buffer local environmental variability in south-eastern Australia by foraging in Antarctic waters. *Movement Ecology* **3**: 16.

Bradley, J.S., Wooller, R.D. and Skira, I.J. (2000). Intermittent breeding in Short-tailed Shearwater *Puffinus tenuirostris*. *Journal of Animal Ecology* **69**: 639-650.

Bradley, J.S., Wooller, R.D., Skira, I.J. and Serventy, D.L. (1989). Age-dependent survival of breeding Short-tailed Shearwaters *Puffinus tenuirostris*. *Journal of Animal Ecology* **58**: 175-188.

Carey, M.J. (2011). Intergenerational transfer of plastic debris by Short-tailed Shearwaters (*Ardenna tenuirostris*). *Emu* **111**: 229-234.

Carey, M.J., Phillips, R.A., Silk, J.R.D. and Shaffer, S.A. (2014). Trans-equatorial migration of Short-tailed Shearwaters revealed by geolocators. *Emu* **114**: 352-359.

Chambers, L.E., Devney, C.A., Congdon, B.C., Dunlop, N., Woehler, E.J. and Dann, P. (2011). Observed and predicted effects of climate on Australian seabirds. *Emu* **111**: 235-251.

Cousin, H.R., Auman, H.J., Alderman, R. and Virtue, P. (2015). The frequency of ingested plastic debris and its effects on body condition of Short-tailed Shearwater (*Puffinus tenuirostris*) pre-fledging chicks in Tasmania, Australia. *Emu* **115**: 6-11.

Fitzherbert, K. (1985). *The role of energetic factors in the evolution of the breeding biology of the Short-tailed Shearwater (Puffinus tenuirostris, TEMMINCK*). PhD. thesis, Monash University, Clayton, Victoria, Australia,

Gottsch, M.D. and Simpson, R.T. (1966). Annual Report of the Woolamai Survey. *VORG Notes* **4**: 5-11.

Harris, M. and Bode, K. (1981). Populations of Little Penguins, Short-tailed Shearwaters and other Seabirds on Phillip Island, Victoria, 1978. *Emu* **81**: 20-28.

Lane, S.G. (1991). Breeding of the Short-tailed Shearwater on Muttonbird Island, New South Wales. *Corella* **15**: 107.

Marchant, S. and Higgins, P.J. (eds.) (1990). *Puffinus tenuirostris* Short-tailed Shearwater. In: *Handbook of Australian, New Zealand and Antarctic Birds Vol. 1.* pp. 632-644. Oxford University Press, Melbourne.

Montague, T.L., Cullen, J.M. and Fitzherbert, K. (1986). The diet of the Short-tailed Shearwater *Puffinus tenuirostris* during its breeding season. *Emu* **86**: 207-213.

Norman, F.I. and Gottsch, M.D. (1969). The Phillip Island colonies of the Tasmanian muttonbird, with special reference to those at Cape Woolamai. *Emu* **69**: 137-144.

Phillips, R.A., Silk, J.R.D., Croxall, J.P., Afanasyev, V. and Briggs, D.R. (2004). Accuracy of geolocator estimates for flying seabirds. *Marine Ecology Progress Series* **266**: 265-272.

Schumann, N., Dann, P. and Arnould, J.P.Y. (2014). The significance of northern-central Bass Strait in south-eastern Australia as habitat for burrowing seabirds. *Emu* **114**: 234-240.

Sedon, G. (1975). Phillip Island; Capability, conflict and compromise. A report to the Westernport Regional Planning Authority. University of Melbourne.

Serventy, D.L. (1970). Longevity records and banding data on Short-tailed Shearwaters. *The Australian Bird Bander* **8**: 61-62.

Serventy, D.L. and Curry, P.J. (1984). Observations on colony size, breeding success, recruitment and inter-colony dispersal in a Tasmanian colony of Short-tailed Shearwaters *Puffinus tenuirostris* over a 30-Year Period. *Emu* **84**: 71-79.

Serventy, D.L., Serventy, V. and Warham, J. (1971). Short-tailed Shearwater. In: *The Handbook of Australian Seabirds*. pp. 128-134. Reed, Sydney.

Skira, I.J. (1991). The Short-tailed Shearwater: A review of its biology. *Corella* **15**: 45-52.

The, T.S. (1971). *The Cape Woolamai faunal reserve: A study of the physical geography and ecology as a basis for conservation managment.* MSc thesis, University of Melbourne, Melbourne.

Vlietstra, L.S. and Parga, J.A. (2002). Long-term changes in the type, but not amount, of ingested plastic particles in short-tailed shearwaters in the southeastern Bering Sea. *Marine Pollution Bulletin* **44**: 945-955.

Yamashita, R., Takada, H., Fukuwaka, M.A. and Watanuki, Y. (2011). Physical and chemical effects of ingested plastic debris on short-tailed shearwaters, *Puffinus tenuirostris*, in the North Pacific Ocean. *Marine Pollution Bulletin* **62**: 2845-2849.

APPENDIX 1

Recoveries away from Australia of Short-tailed Shearwaters banded at Cape Woolamai: 1956 to 2010. * A = adult, N= nestling. # Recovery methods 1. Found beach-washed or floating in sea, 2. Collided with moving ship/boat, 3. Trapped because bird tangled in fishing gear, 4. Band found on bird, no further data on method of encounter. Elapsed years are time between banding and recovery or re-trapping.

Distance moved (km)	Date banded	Age* at banding	Date recovered	Recovery site	Recovery Long., Lat.	Recovery method#	Elapsed years
12 163	6 October 1984	A	1 August 1989	Kodiak Island, Alaska, USA	-151.67, 56.33	1	4.84
11 951	24 March1964	N	27 May 1966	Gulf of Alaska, USA	-149.75, 52.43	3	2.16
11 843	6 April 1963	A	28 July 1965	Port Haiden, Alaska, USA	-157.33, 57.00	1	2.32
11 464	31 March 1963	N	11August 1969	Off Cape Sarichef, Alaska, USA	-165.00, 54.50	2	6.39
11 396	4 April 1965	N	15 July 1965	Bering Sea	-176.03, 59.17	3	0.28
10 419	30 March 1961	N	11 July 1977	North Pacific Ocean	176.83, 51.00	3	16.26
9759	24 March 1962	N	23 June 1962	720 km SSW Attu Island, North Pacific	169.83, 49.97	3	0.25
9629	26 April 1997	N	13 July 1997	At sea off Kuril Islands, Russia	154.68, 46.35	3	0.21
8965	26 March 1961	N	1 May 1962	10 km North Shiriyasaki, Japan	141.50, 42.00	3	1.10
8170	26 March 1961	N	21 May 1961	Off Bonin Island, North Pacific	138.67, 33.33	4	0.15
8048	30 March 1961	N	27 May 1961	64 km East Mikura Island, Japan	140.17, 32.33	3	0.16
7977	9 April 1960	N	25 June 1960	Off Hachijo Island, Japan	139.75, 33.00	3	0.21
7929	30 March 1961	N	20 May 1961	80 km East Hachijo, Japan	141.50, 31.33	3	0.14
7888	16 April 1960	A	27 May 1962	880 km SE Tokyo, North Pacific	140.57, 31.75	3	2.10
2536	3 March 1968	A	24 November 1968	Waikanae Beach, New Zealand	175.00, -40.87	1	0.73
2503	6 October 1984	A	12 November 1988	30 km N Kaitaia Mile Beach, New Zealand	173.17, -35.00	1	4.11
2559	26 April 1997	N	30 October 2013	Ruapuke Beach, Waikato, New Zealand	174.46, -37.54	1	16.57

APPENDIX 2

Retraps and recoveries at other shearwater colonies of Short-tailed Shearwaters banded at Cape Woolamai, Phillip Island, Victoria, 1956 to 2010. *A = adult, N = nestling. # Recovery methods 1. Trapped by hand or with hand-held net, released alive with the band. 2. Taken by domestic or wild dog. ** Each of the recovery sites is a known shearwater breeding colony. @ Breeding colony of Wedge-tailed shearwaters (*Ardenna pacificus*) NSW = New South Wales and VIC = Victoria. Elapsed years are time between banding and recovery or re-trapping.

Distance moved (km)	Date banded	Age* at banding	Date recovered	Recovery site**	Retrap or Recovery Long., Lat.	Retrap or Recovery Method#	Elapsed years
1163	26 January 1998	A	3 September 2001	Mutton Bird Island, Coffs Harbour, NSW@	153.15, -30.30	1	3.62
502	29 April 2000	N	23 November 2001	Montague Island, NSW	150.23, -36.25	1	1.57
272	8 April 1961	N	23 January 1966	Port Fairy Shearwater Colony, VIC	142.23, -38.38	2	4.79
22	14 October 1995	A	7 October 1998	Tankerton Hill, French Island, VIC	145.27, -38.38	1	2.99
17	17 March 1963	N	4 October 1970	Swan Lake, Phillip Island, VIC	145.16, -38.52	1	7.58