Notornis, 2018, Vol. 65: 42–50
0029-4470 © The Ornithological Society of New Zealand Inc.

Observations of Hutton's shearwaters (*Puffinus huttoni*) at a natural colony in the Kōwhai River and a newly established by translocation colony at Te Rae o Atiu, Kaikōura Peninsula

LINDSAY ROWE
The Hutton's Shearwater Charitable Trust, PO Box 58 Kaikōura 7400, New Zealand

Abstract Observations of activities of Hutton's shearwaters at a natural colony in the Kōwhai River and a new colony at Te Rae o Atiu, Kaikōura Peninsula established by translocations were made during the 2014-15 and 2015-16 seasons. Weights and wing lengths of chicks at the 2 colonies taken at comparable times were similar, as were the dates of first emergence and fledging. Thus, adults flying an additional 20 km each way and climbing over 1200 m had no noticeable effect on chick growth at the mountain colony compared to the sea-level colony. Pre-fledging chicks visited other burrows as did adults at both sites, especially at Te Rae o Atiu, where a greater amount of data showed they visited other burrows throughout the season. While some adults stopped visits before fledging, others were still present after chicks had gone. Seven birds that were translocated from the Kōwhai River colony as chicks to Te Rae o Atiu in 2012 and 2013 were recorded at the Kōwhai colony and 2 of these had previously spent 1 night at Te Rae o Atiu; 28 more from the same cohorts were active at Te Rae o Atiu.

Rowe, L. 2018. Observations of Hutton's shearwaters (*Puffinus huttoni*) at a natural colony in the Kōwhai River and a newly established by translocation colony at Te Rae o Atiu, Kaikōura Peninsula. *Notornis 65 (1):* 42–50.

Keywords Hutton's shearwater; *Puffinus huttoni;* Kōwhai River; Te Rae o Atiu; Kaikoura Peninsula

INTRODUCTION

The Hutton's shearwater (*Puffinus huttoni*), first described by Mathews (1912), is currently classified by Birdlife International (2017) as 'Endangered' and as 'Threatened – Nationally Vulnerable' under the New Zealand Threat Classification system (Robertson *et al.* 2017). It is a small black-and-white shearwater (length 36-38 cm; weight 365 gm; Marchant & Higgins 1990) whose breeding grounds were unknown to the scientific community until 1965. Following up on anecdotal reports from Māori, musterers, hunters and Kaikōura locals of "muttonbirds" nesting in burrows high in the Seaward Kaikōura Ranges, Harrow (1965) confirmed there were breeding colonies of Hutton's shearwater in the headwaters of the Kōwhai River at altitudes between 1200 and 1800 m asl. Extensive searching led to the discovery of 8 further populations, but only 2 (Kōwhai River and Shearwater Stream) remain today (Marchant & Higgins 1990; Cuthbert 2001; Sommer *et al.* 2009).

The New Zealand Department of Conservation (DOC) identified the Hutton's shearwater as a threatened species requiring medium term action for its recovery (Molloy & Davis 1992). As a consequence, a draft recovery plan was drawn up that recommended the creation of a third colony at a lowland site (Paton & Davis 1997). A later review of the status of Hutton's shearwater (Cuthbert 2001) also recommended a site be found for a third

Received 29 July 2016; accepted 9 November 2017
Managing Editor: *Dr Paul Sagar*
*Correspondence: *lindsay.jan.rowe@xtra.co.nz*

colony. These recommendations culminated in the establishment of Te Rae o Atiu on the Kaikōura Peninsula on land made available by the, now, Tukete Trust. DOC translocated nearly 300 chicks from the Kōwhai River colony in 2005 through 2008 (Miskelly *et al.* 2009; Rowe 2014) and further translocations were undertaken in 2012 and 2013 by the Hutton's Shearwater Charitable Trust (HSCT) (Rowe 2014).

A passive integrated transponder (PIT) system, similar to that used by Taylor *et al*. (2012) to study Chatham Island tāiko (*Pterodroma magentae*) breeding activity, was used at Te Rae o Atiu to study the movements of the fledging Hutton's shearwater chicks brought down in the 2013 translocation (Rowe 2014). The records showed that many chicks moved considerable distances in the days before fledging and visited many other nestboxes (Rowe 2014). This seemed to be at variance with observations at the Kōwhai River where they had been reported to sit quietly at the burrow entrances before fledging (Cuthbert & Davis 2002; Harrow 1976).

In order to understand whether the data being gathered on Hutton's shearwater chicks at Te Rae o Atiu were similar to that from natural populations, it was proposed to set up a study at the Kōwhai River colony. There, the adult birds have to fly about 20 km further and climb over 1200 m more than at Te Rae o Atiu to provision the chicks, and this could show as differences in chick growth and behaviour. Here we present the results of this comparative study completed over 2 breeding seasons.

MATERIALS AND METHODS

Te Rae o Atiu colony, Kaikōura Peninsula

The Te Rae o Atiu site on the Kaikōura Peninsula (42.43° S 173.70° E) is 80 m asl. Hutton's shearwaters are housed in nestboxes (hereafter referred to as burrows) about 1.5 m apart and with easy access between them (Rowe 2014). For this study monitoring bird movements was undertaken in the breeding seasons of 2014-15 and 2015-16 beginning in early September and ending in early April. This involved weekly daytime observations of burrows to see if birds were present, or if the burrows had been visited as shown by movements of 3 external pins at the burrow entrance and 3 internal pins at the nest chamber mouth. Previous work had shown the outside pins can be moved by other birds and was not evidence of birds attending the nestbox, and that movement of the 3 inner pins can be considered to be a more reliable guide to visits (Rowe 2014).

Since November 2012, PIT tags have been inserted in most of the chicks from the 2006-2008 translocations that have returned as breeding adults, and in all Te Rae o Atiu chicks fledged since March 2013 and in all 2012 and 2013 translocation chicks. The PIT tags, Allflex 11.5mm FDX-B injectable glass transponder implants, were inserted into the back of the neck using an Allflex injector. PIT tag readers were then installed on burrows that had been visited; data downloads were made at about monthly intervals.

Kōwhai River colony

The Kōwhai River study area (42.26°S 173.60°E) is 80 m above Shearwater Hut at an altitude of 1250 m asl. The site is predominantly snow tussock (*Chionochloa* spp.) with some low-ground cover and bare soil (Fig. 1 and 2). The study burrows are within an area of about 300 m^2 that has approximately 400 burrows. Soils are very friable, well drained

Fig. 1. The Kōwhai River study site (1250 m asl) with some PIT tag readers visible in the tussock area just above the *Hoheria* scrub. (Photo L. Rowe)

Fig. 2. Two PIT tag readers sited amongst the tussocks with extensive areas of bare soil. (Photo L. Rowe)

Table 1. Work programme Kōwhai River 2014-2016.

Date	Work
10-12 November 2014	Installed 27 PIT tag readers; PIT tagged 27 adults
19-21 January 2015	Downloaded 27 readers; PIT tagged 8 adults; 21 chicks banded & weighed
17 February 2015	PIT tagged 19 chicks
21 May 2015	Retrieved readers
15 October 2015	Reinstalled 25 PIT tag readers; PIT tagged 2 adults
6 January 2016	Downloaded 17 readers; PIT tagged 1 adult; 14 chicks weighed
3 March 2016	Downloaded 21 readers; 16 chicks weighed, banded & PIT tagged
5 April 2016	Retrieved/downloaded all reader assemblies.

Kaikōura steepland soils with variable depth and stone content. The burrows can be up to 3 m long (Paton & Davis 1997; Cuthbert & Davis 2002) with sharp changes of direction.

A trial was undertaken at Kōwhai River in summer 2013 when PIT tag readers were placed on burrows with birds that had been picked up at burrow entrances and tagged. From that trial we found that tagging a bird at the entrance of a burrow was no guarantee that it was the occupier of that burrow or that there would be an egg or chick present, that kea (*Nestor notabilis*) can pull out reader antennae coils, and that solar panels on the reader assemblies can be covered in dirt by birds excavating burrows resulting in flat batteries.

To be sure that burrows to be monitored were occupied and would likely have chicks fledge, installation visits were delayed until egg incubation was underway in 2014 and 2015 (Table 1). A burrowscope was used to find burrows with birds present and on eggs, and with nest chambers able to be reached through a study hatch or within an arm's length of the burrow entrance to be able to extract birds. Each burrow had an antenna coil fitted into the burrow entrance and connected to an individual reader assembly consisting of a datalogger connected to a 12 v battery charged by a 10 w solar panel (Fig. 3; Rowe 2014).

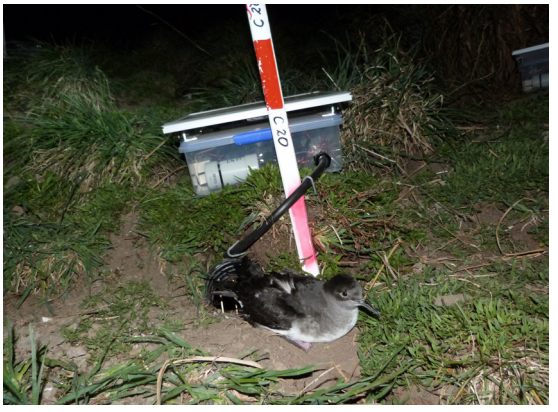

Fig. 3. Hutton's shearwater at the entrance to burrow C20 at the Kōwhai River colony with the antenna coil in place and attached to the reader assembly. (Photo L. Rowe)

In each of 27 accessible burrows, adult birds were implanted with PIT tags when first caught, either in 2014–15 or 2015–16. Ideally, we would have tagged both adults from each burrow. With adults changing over at intervals of several nights and our short stays, it was not possible to get all pairs tagged, especially when poor weather curtailed/prevented several planned trips or meant no field work could take place because of underfoot conditions. Consequently, over time, both parents were PIT tagged in only 10 burrows. Another problem at this site was that some burrows had a second entrance we did not find, and the birds did not use the entrance with the reader; a second problem was birds digging new entrances by-passing the antenna coil. Battery/solar-panel/reader malfunctions resulted in some loss of records.

At both sites, the wing lengths of the birds were determined to 1 mm using the 'maximum chord' method with a stop-end ruler as described by Melville (2011). Small chicks were weighed in a container on an electronic scale to 1 gm and larger birds were weighed in a bird bag using a 1000 g Pesola spring balance.

RESULTS

Chick growth and movements

The weights and wing lengths for chicks in the study burrows at both sites taken at similar dates are given in Table 2. January data are for chicks

Table 2. Weights and wing lengths of chicks measured on similar 2014-15 dates at Te Rae o Atiu and Kōwhai River colonies.

	Weight (gm)				Wing length (mm)	
Colony	Te Rae o Atiu	Kōwhai River	Te Rae o Atiu	Kōwhai River	Te Rae o Atiu	Kōwhai River
Date	22/1/15	19/1/15	16/2/15	17/2/15	16/2/15	17/2/15
Number	7	21	7	20	7	20
Maximum	515	485	625	745	197	192
Minimum	207	185	365	325	100	138
Mean	387	350	538	567	164	164
Standard deviation	98	76	82	105	31	18
95% confidence limits	69	33	61	48	23	8
Bartlett's test χ^2 ($\chi^2_{df=1, p=0.05}$)	0.64 (3.84)		0.51 (3.84)		3.60 (3.84)	
t-test ($t_{0.05}$)	-1.024 (2.056)		0.661 (2.060)		0.030 (2.060)	
2015-2016	5/1/16	6/1/16	29/2/16	2/3/16	29/2/16	2/3/16
Number	7	14	7	16	7	16
Maximum	335	310	642	680	225	231
Minimum	134	60	485	370	173	181
Mean	257	210	550	548	212	211
Standard deviation	69	78	48	71	20	15
95% confidence limits	51	41	35	35	15	7
Bartlett's test χ^2 ($\chi^2_{df=1, p=0.05}$)	0.12 (3.84)		1.13 (3.84)		0.85 (3.84)	
t-test ($t_{0.05}$)	-1.305 (2.093)		-0.088 (2.086)		-0.018 (2.086)	

between approximately 12 and 28 days old. In mid-February chicks were being actively fed and at about peak weights, while the March data were for chicks close to peak weights or in a period of body weight decline as they lost weight prior to fledging. Wing length measurements were taken in an active growth phase. Both weights and wing lengths were very similar for the 2 sites at comparable times; as summarised in Table 2, the variances of the data being compared were homogeneous (Bartlett's test for homogeneity of variance (Freese 1967)), the 95% confidence limits of the means overlapped, and t-test values were all under the $t_{0.05}$ table thresholds (Freese, 1967). Thus, there were no differences in chick development that could be attributed to sites.

Table 3 lists the first emergence and fledging dates for chicks at both sites. It is assumed that the first record on the PIT reader indicates the first emergence of a chick from its burrow and the last record is fledging date rather than chicks moving to other burrows before fledging. Even though the samples from Te Rae o Atiu are small, there was no statistically significant difference in mean dates of first emergence and fledging at both sites within each season (Table 3). A comparison of within-site data between years showed no significant differences at the Kōwhai River colony for fledging but there were significant differences at Te Rae o Atiu (Table 4). Some birds at the Kōwhai colony appear to have fledged the night of first emergence from their burrows, whereas others were recorded at burrow mouths up to 18 days before leaving. At Te Rae o Atiu, translocated birds moved to the burrow entrances for up to 22 days before fledging. Nearly all birds from both colonies fledged within the period when fallout mountain birds "crash-landing" on the Kaikōura Peninsula on their first flights to the sea were banded, 15-29 March 2015 and 7 March – 12 April 2016 (L. Rowe, *unpubl. data*).

There were 2 2015-16 records of Kōwhai River chicks triggering PIT-tag readers away from their "home" burrows: X21210 at burrows KOW04 (home) and F1; X21211 at KOW09 (home) and KOW06. At Te Rae o Atiu over the 2 seasons we

Table 3. Dates when chicks were recorded by PIT tag readers first emerging from their burrow and then fledging at the Kōwhai River and Te Rae o Atiu colonies.

	2014-15		2015-16	
	Kōwhai	Te Rae o Atiu	Kōwhai	Te Rae o Atiu
Number of birds	17	4	14	6
Earliest emergence date	26 February	5 March	2 March	5 March
Last emergence date	20 March	15 March	21 March	28 March
Mean emergence date	13 March	11 March	7 March	12 March
Bartlett's test χ^2 ($\chi^2_{df=1,\ p=0.05}$)	0.67 (3.84)		1.26 (3.84)	
t-test ($t_{0.05}$)	0.325 (2.093)		-1.767 (2.093)	
First fledging date	15 March	16 March	7 March	16 March
Last fledging date	30 March	2 April	26 March	6 April
Mean fledging date	23 March	22 March	17 March	24 March
Bartlett's test χ^2 ($\chi^2_{df=1,\ p=0.05}$)	2.23 (3.84)		0.35 (3.84)	
t-test ($t_{0.05}$)	-1.141 (2.093)		-1.806 (2.101)	
Range (emergence to fledging)	3 – 18 days	11 - 22 days	0 – 18 days	6 – 16 days

recorded 5 of 14 birds away from their natal burrow at least once, but reader densities were higher there.

Adult movements

Ten breeding adult Hutton's shearwaters at the Kōwhai River colony were recorded triggering the antennae coils at burrows other than those from which they were found on eggs. One bird in 2014-15 and 2 in 2015–16 triggered more than 1 other reader in a season; 3 birds triggered more than 1 reader in both years. In 2014-15 at Te Rae o Atiu, where the density of monitored burrows is higher, 19 of 26 birds associated with an egg in a burrow visited up to 19 other monitored burrows. In 2015–16 the number was 18 of 21 birds visiting up to 15 burrows; many of these visits were one-offs for a particular burrow. These visits occurred throughout the season - during pre-laying, incubation and chick rearing phases.

The PIT tag readers also provided times when adults were present and when the chicks fledged. At the Kōwhai River, most burrows had single birds monitored and it is possible that the second parent may have been in attendance after the monitored parent stopped feeding; the single bird data, therefore, needs to be considered with caution. Table 5 shows that adult birds may not be present for significant periods before the chicks fledge, but other adults have been observed at burrows up to 5 days after the chicks had gone. There are some extreme records of adult birds, presumably parents, not having been at the burrows for over 40 days before the chicks fledged (Table 5).

Return of translocated birds

Of the 200 Hutton's shearwater chicks taken down to Te Rae o Atiu as part of the 2012 and 2013 translocations, about 50 each year were taken from the Kōwhai sub-colony under study here. During the 2014-15 season, 1 2012 bird returned to Te Rae o Atiu and 27 birds returned in 2015-16 (12 from 2012 and 15 from 2013). Nearly all birds were recorded from PIT tag records only - there were only 5 visual sightings. The PIT tag data from the Kōwhai River recorded 7 birds that were translocated to Te Rae o Atiu in 2012 and 2013, despite only 27 of c.400 burrows being monitored (Table 6); none was seen. One bird, banded X17297, was recorded at 2 Kōwhai River burrows in January 2015 and in 4 burrows the next season. Two of the birds recorded at the Kōwhai River were first recorded on 1 day only at Te Rae o Atiu (early in the 2015–16 season) before returning to the source colony (Table 6).

The translocation process had chicks blocked in their nestboxes for about 5 days, after which they were allowed to move freely about the Te Rae o Atiu colony. Three of the 2012 birds that returned to Kōwhai River left Te Rae o Atiu within 5 days of the nestbox block being removed; the other birds were free between 11 and 18 days before leaving. It is probable that the period of exposure to the outside world was much shorter than the time free, as PIT readers showed the 2 2013 birds were at the nestbox entrance for only 7 and 9 days before

Table 4. Comparison by years when chicks first emerged from their burrow and then fledged at the Kōwhai River and Te Rae o Atiu colonies

	Kōwhai		Te Rae o Atiu	
	2014-15	2015-16	2014-15	2015-16
Number of birds	17	14	4	6
Earliest emergence date	26 February	2 March	5 March	5 March
Last emergence date	20 March	21 March	15 March	28 March
Mean emergence date	13 March	7 March	11 March	12 March
Bartlett's test χ^2 ($\chi^2_{df=1, p=0.05}$)	0.07 (3.84)		1.62 (3.84)	
t-test ($t_{0.05}$)	2.837 (2.045)		-0.091 (2.262)	
First fledging date	15 March	7 March	16 March	16 March
Last fledging date	30 March	26 March	2 April	6 April
Mean fledging date	23 March	17 March	22 March	24 March
Bartlett's test χ^2 ($\chi^2_{df=1, p=0.05}$)	3.46 (3.84)		0.06 (3.84)	
t-test ($t_{0.05}$)	-2.899 (2.045)		0.462 (2.306)	
Range (emergence to fledging)	3 – 18 days	0 – 18 days	11 - 22 days	6 – 16 days

fledging compared to the 17 and 15 days that they were free. It is not known what the actual length of exposure was for the 2012 birds as PIT tag readers were not deployed at Te Rae o Atiu that season. Table 7 indicates translocated birds that returned to both the Kōwhai River and Te Rae o Atiu colonies had similar periods free and at nestbox entrances before fledging

Two of the returned birds at the Kōwhai River were recorded at 4 burrows in a season. This is probably an underestimate of burrows visited as only a small proportion of the burrows were monitored. Observations at Te Rae o Atiu showed that most returning birds visited more than 1 burrow, with birds recorded in up to 15 burrows in their first season back (Rowe *unpubl. data*).

DISCUSSION

Chick growth and movements

There were no apparent differences in the chick weights and wing length measurements at the 2 sites for comparable dates. Similarly, the mean dates for first emergence from the burrows and fledging were not significantly different. This implies that chick development at the 2 sites was similar despite the higher energetic cost of carrying food to chicks at the Kōwhai River colony, the adults having to climb over 1200 m more and fly an extra 20 km each way compared to Te Rae o Atiu. Cuthbert & Davis (2002) noted that rearing Hutton's shearwaters chicks in the mountain colonies took longer at 84

Table 5. Number of days between the last attendance by parents and the chick fledging. A negative number means the adult was present after the chick fledged.

	2014-2015		2015-2016	
Te Rae o Atiu	*Female*	*Male*	*Female*	*Male*
Box 21	5	4		
Box 41			25	25
Box 42			22	11
Box 45			17	5
Box 46			15	53
Box 51	24	4		
Box 59			25	11
Box 70	6	-2		
Box 72				10
Box 97	16	5		
Kōwhai River	*Adult 1*	*Adult 2*	*Adult 1*	*Adult 2*
A10	0	5	0	61
A57			-1	-2
A65			8	73
C23	2	4	15	16
Single birds	13 records; range 10 to -5		7 records; range 49 to -1	

Table 6. Birds translocated as chicks to Te Rae o Atiu from the Kōwhai River that returned to the natal colony. Days free is the number of days between the block being removed from the translocation nestbox to fledging at Te Rae o Atiu; days at entrance is the length of period prior to fledging when the readers recorded birds at the burrow tunnel mouth.

Bird number	Translocation year	Kōwhai burrow	Date recorded	Te Rae o Atiu nestbox	Date recorded	Days free	Days at entrance
X17255	2012	Kow09	21/12/15	42	1/11/15	11	
X17256	2012	A26	10/12/15			18	
X17269	2012	Kow07	21/12/15	40	14/11/15	5	
X17297	2012	A9 A26 A26 Kow03 C20 F1	20/1/15 12/1/15 17/10/15 3/11/15 9/11/15 17/11/15			1	
X17317	2012	Kow10 A28	4/12/15-23/1/16 22/10/15			5	
X19700	2013	Kow04	7/1/16			17	9
X19704	2013	F1 Kow04 A57 Kow09	21/12/15 1-7/1/16 3/2/16 8/2/16			15	7

Table 7. Comparison of the number of days birds found at the Kōwhai River and Te Rae o Atiu colonies were free to move about or were recorded at the nestbox entrances at Te Rae o Atiu before fledging after the 2012 and 2013 translocations.

	Days free		Days at entrance	
	Kōwhai	Te Rae o Atiu	Kōwhai	Te Rae o Atiu
Number of birds	7	24	2	12
Average	10	13	8	11
Maximum	18	26	9	17
Minimum	1	1	7	6
Bartlett's test χ^2 ($\chi^2_{df=1, p=0.05}$)	0.15 (3.84)		0.80 (3.84)	
t-test ($t_{0.05}$)	1.133 (2.045)		1.446 (2.179)	

days compared to, for example, Manx shearwaters (*P. puffinus*) at 71 days and Audubon's shearwater (*P. lherminieri*) at 75 days. Unfortunately, there are no chick rearing data available for fluttering shearwaters (*P. gavia*), a similar species to Hutton's shearwater with a colony breeding at sea-level in the Marlborough Sounds 150 km distant (Marchant & Higgins 1990; Gaskin 2013). Cuthbert & Davis (2002) suggested that the longer chick-rearing phase for Hutton's shearwaters may reflect the higher energetic cost of getting food to the chicks but, within the limitations of the data here, is not shown by differences in chick size between the mountain and sea-level sites.

Some chicks at the Kōwhai River appear to have fledged the day of first emergence, whereas others were coming to the burrow mouths up to 18 days before fledging; similarly, at Te Rae o Atiu birds moved to the burrow entrances up to 22 days before fledging. Previous observations at the Kōwhai River colony showed that nestlings approaching fledging age spent 4 or 5 nights at the burrow entrances before fledging, and only rarely were they seen or captured out of their burrows (Cuthbert 2001; Cuthbert & Davis 2002). This study has shown Kōwhai River chicks triggering the readers at

other burrows before fledging, which is similar to Te Rae o Atiu where translocated chicks travelled considerable distances and entered other burrows before fledging (Rowe 2014); some Te Rae o Atiu natural chicks have done the same but to a more limited extent. Translocated fluttering shearwaters chicks at Mana Island have been shown to visit other shearwater, and even fairy prion (*Pachyptila turtur*), burrows (FOMI 2015). Thus, the movements of pre-fledging translocated chicks at Te Rae o Atiu may be normal as shown by the limited data for natural chicks collected at both sites, and not a consequence of the translocation process.

Adult movements

Breeding adult Hutton's shearwaters at both colonies have been recorded triggering the antennae coils at burrows other than those from which they were found when on eggs. Birds made more visits to other burrows at Te Rae o Atiu than the Kōwhai River, but this probably reflects the greater density of monitored burrows. At Te Rae o Atiu especially, visits to other burrows occurred at any time during the season. Some of these birds making visits to other than their "home" burrow were actively involved with chick rearing, whereas failed breeders and non-breeders may be scouting for future mates, and they did visit burrows with chicks.

Fledging occurs when parents stop bringing food to fully feathered chicks (Marchant & Higgins 1990). Chicks gain weight until they peak at an average 540 g at 65 days, then lose weight to an average of 440 g at fledging (Cuthbert 2001; Cuthbert & Davis 2002). Neither site here provided clearcut conclusions about when the adults cease feeding as there were instances of adults being present after fledging. While some parents were not present for several days before fledging, there were some extreme records of adult birds, presumably a parent, not having been at the burrows for over 40 days before the chicks fledged. Whether this was a loss of a bird, or one parent leaving the other to feed the chick, or failure of the reader to record the PIT tag is not known.

Return of translocated birds

This study provides clear evidence that some translocated Hutton's shearwater chicks return to their natal colonies. Until now, there had been no recoveries of Hutton's shearwaters from the 2005-2008 translocations at the Kōwhai River colony despite many visits by research parties. Seven chicks that were taken to Te Rae o Atiu as part of the 2012 and 2013 translocations have now been recorded back at the Kōwhai River. Again, none was seen, but their presence was recorded by the PIT readers. It is not unexpected that translocated Hutton's shearwaters could be found back at their natal colony as studies of other shearwaters have shown some birds do not imprint on their translocation site. For example, Bell *et al*. (2005) reported a fluttering shearwater chick that fledged 3 days after being translocated from Long Island in the Marlborough Sounds to Maud Island had been seen back at its natal colony. In another case, at least 8 fluttering shearwater chicks translocated from Long Island to Mana Island had been found at Matiu/Somes Island (FOMI 2015) where other Long Island birds had been taken in separate translocations (MSICT 2015).

The 2 2013 birds recovered at the Kōwhai River were at the Te Rae o Atiu colony surface for 7 and 9 days before fledging. This was at the lower end of the range for the birds that returned to Te Rae o Atiu. While there is more data for 2012 and 2013 using time when birds were assumed to emerge first as indicated by pins at the nestbox tunnel entrances being moved to fledging, that has been shown to be an unreliable measure of exposure as some birds did not move out of the nestbox for up to 13 days after the pins were down, presumably knocked over by nestlings wandering past (Rowe 2014). Using days free and days at the entrance as measures, there were no differences between those birds that returned to Te Rae o Atiu or returned to the natal colony.

Two of the birds that returned to the Kōwhai River also spent 1 night at Te Rae o Atiu; 1 had been free for 5 days and the other 11 days before fledging. One explanation could be that the imprint to Te Rae o Atiu was weak and has been subsumed while part of large rafts of birds at sea (up to 20,000; Marchant & Higgins 1990) most of whom eventually left for the mountain colonies, and they rehomed to their natal site.

Losing birds to the natal colony after translocations is not ideal and is costly. This begs the question as to whether birds should somehow be restricted from leaving for an extended period after first emergence to allow further site-imprinting to occur.

CONCLUSION

Within the limitations of the data presented here, there are no clear differences in chick measurements and fledging dates and adult behaviour at a colony derived from translocated chicks, Te Rae o Atiu near sea-level, and the natal colony at 1250 m asl in the Kōwhai River and with an additional 20 km flight path from the sea.

This study has shown the benefits of using techniques such as PIT tagging to monitor translocated birds. Many observations here, and

especially the return of translocated chicks to their natal colony, would not have been possible without the electronic record.

ACKNOWLEDGEMENTS

The Hutton's Shearwater Charitable Trust is grateful to all those who assisted with this project as without their support this work would not have been carried out. Funding for this study was provided by: New Zealand Lottery Grants Board Environmental and Heritage (LEH) grant 272944 and the Mohammed bin Zayed Species Conservation Fund project 0925432 for the reader assemblies; LEH and the Birds New Zealand Research Fund (BNZRF) for the PIT tags; BNZRF and HSCT for logistical support; and The Sargood Bequest for equipment. Sistema Plastics supplied the reader boxes and Reid Technology assisted with the solar panels, batteries and solar panel regulators. Della Bennet and DOC staff (especially Mike Morrissey) provided on-site support at the Kōwhai River site, with HSCT trustees and numerous volunteers helping at Te Rae o Atiu. Input from the editors and anonymous referees greatly improved the manuscript.

REFERENCES

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.

BirdLife International 2017. Species factsheet: *Puffinus huttoni*. Downloaded from http://www.birdlife.org on 07/09/2017.

Cuthbert, R.J. 2001. Conservation and ecology of Hutton's shearwater (*Puffinus huttoni*). *Conservation Advisory Science Notes No.* 335. Wellington, Department of Conservation.

Cuthbert, R.; Davis, L.S. 2002. The breeding biology of Hutton's shearwater. *Emu 102*: 323–329.

Freese, F. 1967. *Elementary statistical methods for foresters*. United States Department of Agriculture, Forest Service.

FOMI (Friends of Mana Island Inc) 2015. Fluttering shearwater report filed by Helen Gummer. *FOMI newsletter 63:* 3.

Gaskin, C.P. 2013. Fluttering shearwater. *In:* Miskelly, C.M. (*ed.*) *New Zealand birds online.* www.nzbirdsonline.org.nz.

Harrow, G. 1965. Preliminary report on discovery of nesting site of Hutton's shearwater. *Notornis 12:* 59-65.

Harrow, G. 1976. Some observations on Hutton's shearwater. *Notornis 23*: 269–288.

Marchant, S.; Higgins, P.J. (*eds.*) 1990. *Handbook of Australian, New Zealand and Antarctic birds, Volume 1: Ratites to ducks.* Melbourne, Oxford University Press.

Mathews, G.M. 1912. Snares brown-backed petrel *Puffinus reinholdi huttoni. The birds of Australia. Vol. 2*. London, H.F. and G. Witherby.

MSICT (Matiu Somes Island Charitable Trust). 2015. Fluttering shearwater. Matiu Somes Island Charitable Trust. www.matiusomestrust.org.nz/news/fluttering-shearwater-pakaha/

Melville, D.S. 2011. *New Zealand National Bird Banding Scheme: bird bander's manual.* Wellington, Department of Conservation.

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.

Molloy, J.; Davis, A. 1992. *Setting priorities for the conservation of New Zealand's threatened plants and animals.* Wellington, Department of Conservation.

Paton, B.; Davis, A. 1997. Hutton's shearwater recovery plan (*Puffinus huttoni*). *Threatened Species Recovery Plan Series.* Wellington, Department of Conservation.

Robertson, H.A.; Baird, K.; Dowding, J.E.; Elliot, G.P.; Hitchmough, R.A.; Miskelly, C.M.; McArthur, N.; O'Donnell, C.J.F.; Sagar, P.M.; Scofield, R.P.; Taylor, G.A. 2017. Conservation status of New Zealand birds, 2016. *New Zealand Threat Classification Series 19.* Wellington, Department of Conservation.

Rowe, L.K. 2014. Post-translocation movements of pre-fledging Hutton's shearwaters (*Puffinus huttoni)* within a newly established colony (Te Rae o Atiu) on the Kaikōura Peninsula. *Notornis 61:* 84–90.

Sommer, E.; Bell, M.; Bradfield, P.; Dunlop, K.; Gaze, P.; Harrow, G.; McGahan, P.; Morrissey, M.; Walford, D.; Cuthbert, R. 2009. Population trends, breeding success and predation rates of Hutton's shearwater (*Puffinus huttoni*): a 20 year assessment. *Notornis 56:* 144–153.

Taylor, G.A.; Cockburn, S.; Palmer, D.; Liddy, P. 2012. Breeding activity of Chatham Island taiko (*Pterodroma magentae*) monitored using PIT tag recorders. *New Zealand Journal of Ecology 36:* 425–432.