



Flesh-footed shearwater population monitoring on Ohinau and Lady Alice Islands, 2016/17 report



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ABSTRACT

This report covers the population monitoring of flesh-footed shearwaters (*Puffinus carneipes*) on Ohinau and Lady Alice Islands carried out under Conservation Services Programme project POP2015-02. This is the first year of intensive monitoring for the entirety of the breeding season for both populations. Some preliminary monitoring and banding of the Ohinau Island population was conducted in April/May 2016. A total of 661 birds were banded on Ohinau Island and 379 on Lady Alice Island during this season. A total of 229 study burrows were monitored on Ohinau Island and 179 on Lady Alice Island. A further 35 burrows on Ohinau Island and 30 burrows on Lady Alice Island were monitored by burrowscope only to assess if there was any effects of our monitoring. No effect was detected with burrowscope burrows having a lower breeding success than study burrows. At least one partner was identified in 91% and 72% of all study burrows for Ohinau Island and Lady Alice Island respectively. Three hundred and ninety-nine eggs were laid in all burrows combined and the overall breeding success (chicks that are likely to survive to fledging) for the season was 49.1%. This result is the first measured for a New Zealand population of flesh-footed shearwaters. It is similar to that measured in some Australian populations, but we suspect that due to heavy rain and possible flooding of burrows it is slightly lower than could normally be expected. The high number of grey-faced petrels (*Pterodroma gouldi*) present on both islands is possibly also affecting breeding success. Ongoing and repeated monitoring of both islands will continue and more robust conclusions about the population trends of flesh-footed shearwaters in New Zealand can be made.

Keywords seabirds, flesh-footed shearwater, Ohinau Island, Lady Alice Island, breeding success

1. INTRODUCTION

The population dynamics of Flesh-footed Shearwaters (*Puffinus carneipes*) are not well understood due to a lack of basic demographic data. Previous estimates have placed the global population at 650,000 individuals (Brooke 2004). Recent findings by Lavers (2015) suggest that the population is significantly smaller, numbering < 74,000 breeding pairs globally. In New Zealand, the most recent estimates place the population at 10,000 – 15,000 breeding pairs (Baker *et al.* 2010, Waugh *et al.* 2013), although Bell and Boyle (2017) have raised some concerns that this population estimate is low.

Flesh-footed shearwater populations are in decline both in New Zealand and globally. Under the New Zealand threat classification, the decline of Flesh-footed shearwaters has been recognised and as such the species is now ranked as "Nationally Vulnerable" (Robertson *et al.* 2017). This decline has been attributed primarily to bycatch in commercial fisheries and recreational fisheries. Observers on commercial fishing boats off the east coast of Australia indicated that flesh-footed shearwaters were one of the most commonly killed seabirds in longline fisheries (Baker and Wise 2005). In New Zealand, it is estimated that between 1,079 and 1,769 flesh-footed shearwaters are killed annually by commercial fishermen (Richard *et al.* 2011). Looking at the causes of seabird mortality in the Bay of Plenty, Tennyson *et al.* (2012) found that all fifteen necropsied flesh-footed shearwaters had been killed in fishing-related activities. Most of these deaths were attributed to physical trauma such as broken wings, crushed skulls and stab wounds, while two of the birds contained hooks used by recreational fishermen.

The decline of flesh-footed shearwaters coupled with a general lack of demographic parameter measurements, particularly in New Zealand, means that there is a need to establish long-term population studies. Long-term studies will help gain a better understanding of demographic parameters such as adult survival, age at first breeding, fecundity and recruitment. This will then help provide more accurate population trends and thus aid in future management decisions for the species.

The need to establish long-term studies is warranted and recommendations for such have been made in previous studies (Waugh *et al.* 2014; Barbraud *et al.* 2014). Lady Alice Island and Ohinau Island have both been identified as being suitable sites for such long-term studies due to being relatively easy to access and having relatively large colony sizes (Waugh *et al.* 2014).

1.1 Previous studies on islands

Previous field studies of flesh-footed shearwaters have been carried out on both Ohinau and Lady Alice Islands. GPS tracking work was carried out on Ohinau Island in 2012 with approximately 50 burrows being marked and 62 adult birds banded (Waugh *et al.* 2014). In April 2016, Wildlife Management International Limited (WMIL) continued on Ohinau Island by conducting preliminary work for the current study by finding and marking burrows containing flesh-footed shearwater chicks. We expanded the number of marked burrows to 218 and banded a further 357 individuals (Mischler 2016).

Flesh-footed shearwaters were monitored on Lady Alice Island for 13 consecutive seasons starting from 2000 - 2013 with 596 adults and 193 chicks banded (Andrea Booth unpublished dataset, Barbraud *et al.* 2014). Waugh *et al.* (2014) conducted GPS tracking of flesh-footed shearwaters in 2012 on the island, however, this was not overly successful. Work was not carried out by WMIL on Lady Alice Island during the first year of the current study due to access complications.

1.2 Key Objective and Outputs

This research was carried out as part of the Flesh-footed Shearwater: Various Locations Population Project (POP2015-02). The key objective we were funded to complete was:

Objective 2: To estimate key demographic parameters of flesh-footed shearwater at Lady Alice Island/Mauimua and Ohinau Islands.

To meet this objective, the following outputs were to be delivered in 2016/17:

- Establish and identify the partners in up to 200 study burrows on each island.
- Determine the sex of birds in study burrows by cloacal examination where possible.
- Determine the breeding success of all study burrows and where possible record cause of burrow failure.
- Monitor ≥ 30 burrowscope burrows on both islands to determine if there was any effect of handler disturbance on breeding success.
- Band as many adults on the surface at night to increase the banded population of flesh-footed shearwaters.
- Band all chicks in study burrows prior to fledging.
- Band as many chicks on the surface prior to fledging to increase the number of banded chicks each season.
- Record details of any recaptured banded birds.

2. METHODS

2.1 Study Sites and Dates

2.1.1 Ohinau Island

Ohinau Island (Mercury Islands Group, 36.73°S, 175.88°E) is a 43ha island located off the east coast of Coromandel Peninsula (Figure 1). The island is owned by local iwi Ngati Hei and co-managed with the Department of Conservation. There are an estimated 2,071 (943 – 3200, 95% CI) occupied flesh-footed shearwater burrows on the island (Baker *et al.* 2010). Burrows are distributed over the entire island in eight colonies (Figure 2). We focussed our study on five of these colonies and left the other three undisturbed. A team of two personnel was based on the island during the following dates:

- 30 November 2016 – 19 December 2016
 - Finding and monitoring study burrows during egg-laying and incubation.
- 27 April 2017 – 02 May 2017
 - Determining results for all study burrows prior to fledging.

2.1.2 Lady Alice Island

Lady Alice Island / Mauimua (Hen and Chickens Group, 35.89°S, 174.72°E) is a 155 ha Nature Reserve located 40km southeast of Whangarei (Figure 1). There are an estimated 921 (237- 1,605, 95% CI) occupied flesh-footed shearwater burrows on the island (Baker *et al.* 2010). Seven main sub-colonies on Lady Alice Island have been identified (Figure 3). This study focussed on in the LA1 colony which has been monitored for 13 seasons between 1999 and 2012 (Barbraud *et al.* 2014). A team of two personnel was based on the island during the following dates:

- 03 December 2016 – 19 December 2016
 - Finding and monitoring study burrows during egg-laying and incubation.
- 31 January 2017 – 22 February 2017
 - GPS tracking adults during early chick rearing.
- 20 April 2017 – 26 April 2017
 - Determining results for all study burrows prior to fledging.

Figure 1. Location of Lady Alice Island and Ohinau Island.

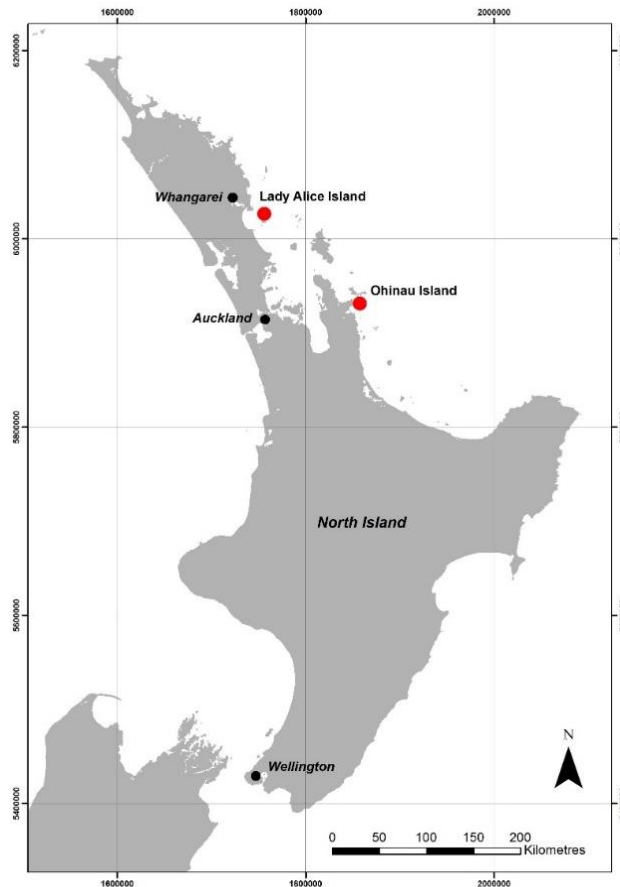


Figure 2. Location of flesh-footed shearwater colonies, Ohinau Island.

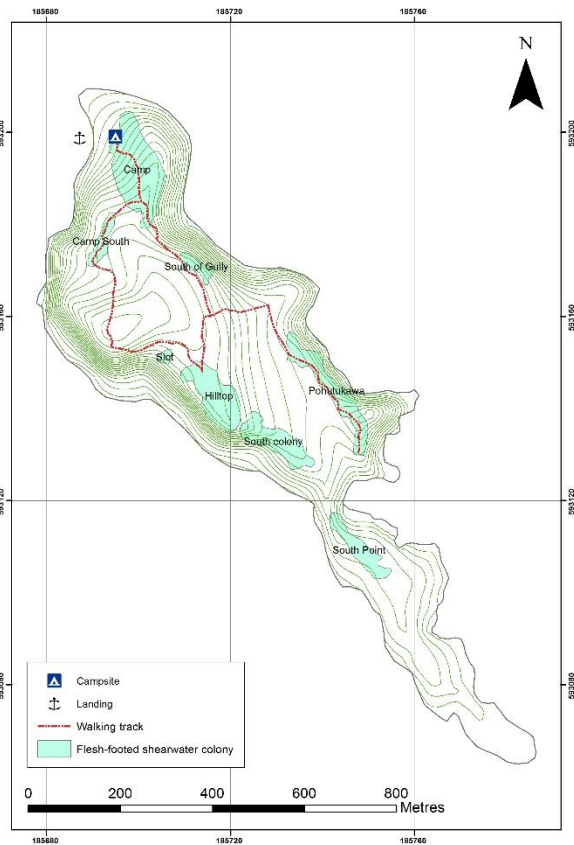
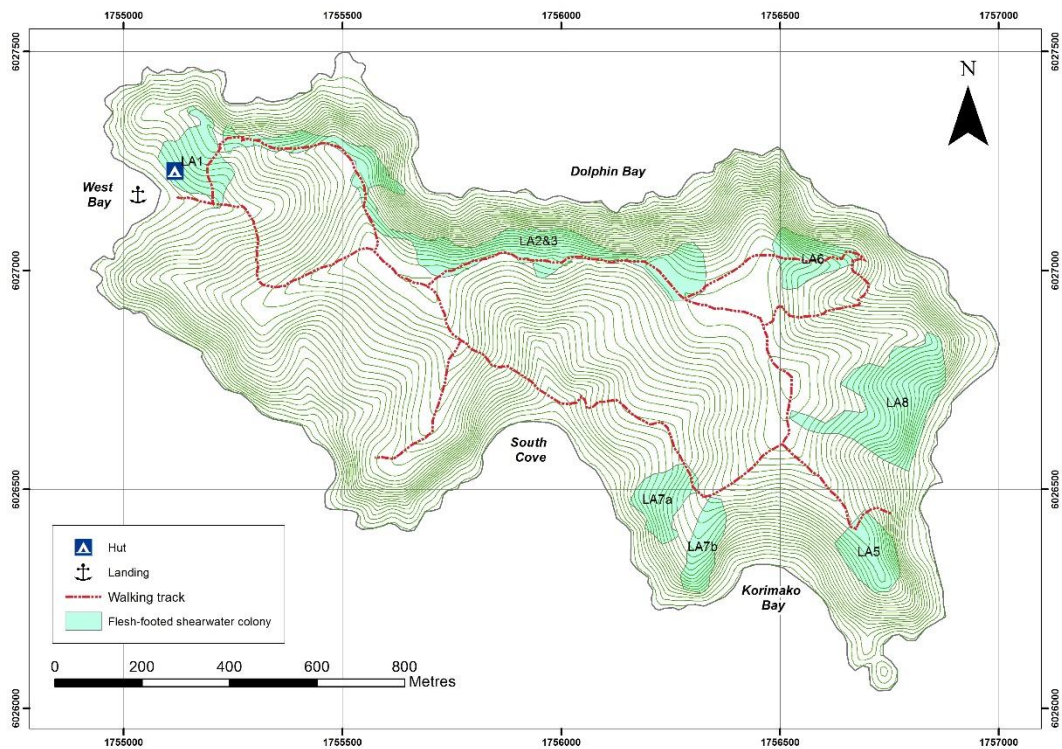


Figure 3. Location of flesh-footed shearwater colonies, Lady Alice Island. All burrows monitored in this study were situated in LA1 colony.



2.2 Burrow Monitoring

Study burrows were established during the daytime. The contents of burrows were checked by reaching down the burrow mouth by hand or feeling with a stick to see if a bird and/or egg was present. If the bird could be reached by hand it was pulled out of the burrow mouth. If it was felt with a stick, an inspection hatch was dug to enable access to the chamber and bird. These hatches were sealed with a square of plywood or a large rock. Burrows were all given a unique identifier, GPS location and marked with a pink plastic tag.

During egg laying (December), each study burrow was checked every second day. All birds found in these burrows were banded and where possible the sex of the bird was determined by cloacal examination. For birds that could not be sexed, a sample of two breast feathers was taken to allow for DNA sexing. We also measured wing length, head and bill length, minimum bill depth and weight. All birds banded were marked with correction fluid to prevent handling a second time and placed back in their burrow. Once an egg was found in a burrow and both partners had been identified and banded, the burrow was no longer checked for the duration of the trip. This helped minimise disturbance to the birds and burrow.

Burrowscope burrows were checked only once during the trip. This was carried out near the end of the trip once it was assumed the majority of breeding birds had laid. The burrowscope was fed down the mouth of the burrow until a bird was seen and confirmed incubating an egg. If no bird was seen after a thorough search, the burrow was recorded as being empty. No hatches were dug in to burrowscope burrows.

In February 2017, Lady Alice Island was visited to track adult flesh-footed shearwaters using GPS during early-chick rearing. The results of this tracking are not discussed in this report (see Kirk *et al.* 2017), however, some birds were caught and banded during this trip and those birds have been included in analyses here.

In April/May, both islands were revisited and all burrows were checked. All study burrows were checked regardless of their status in December. Chicks found in burrows were banded, weighed and had wing length measured then placed back in their burrows. Because chicks fledge in early May (Priddel *et al.* 2006), burrows with chicks during this time were assumed to have bred successfully. Where possible the cause of failed breeding attempts was recorded. Empty burrows were checked thoroughly to make sure there was no sign of a chick or egg.

All burrowscope burrows were checked again in April/May. Chicks were removed where possible by hand or leg hook to be banded and have measurements taken (as above) then placed back in their burrow. Empty burrows and failed burrows were confirmed using a burrowscope or/and burrow probing with a stick.

2.3 Night Work

2.3.1 December Trip

Night work was carried out to increase the total number of banded birds and to recapture banded birds. Night work was primarily carried out between 01:00 and dawn. Adults were caught using a hand-net and were banded, marked with correction fluid and the capture location was recorded. Take-off “runs” were targeted during the pre-dawn exodus as this is where we would see a large number of birds funnelling in to a relatively small area to take off.

2.3.2 April Trip

Night work on this trip primarily aimed to catch any chicks coming out of burrows exercising and preparing to fledge. Chicks were banded, weighed and had wing length measured. There was no

apparent preferred time for chicks to be on the surface so catching took place at any time after dark. Chicks seemed to spend very little time on the surface and therefore not many were caught. Some adults were still present on the islands at this point and were also captured. Adults were banded and weighed to determine post-breeding weights.

3. RESULTS

3.1 Study Burrows

3.1.1 Ohinau Island

All 186 study burrows found and marked by WMIL in April 2016 were located. There was a high rate of occupancy (burrows with eggs) in these burrows with 90.3% having eggs in both the 2015/16 and 2016/17 seasons. An additional 43 burrows, all of which contained eggs, were added to bring the total number of burrows monitored on Ohinau Island to 229 (Table 1). This brought the total number of occupied burrows (burrows with eggs) up to 209 (Table 3).

Table 1. Number of study burrows monitored in the 2016/17 breeding season, Ohinau Island.

Colony	Burrows 2015/16	New burrows 2016/17	Total burrows monitored 2016/17
Camp	30	10	40
Camp south	35	10	45
Hilltop	40	9	49
Pohutukawa	51	5	56
South of gully	30	9	39
Study burrows	186	43	229
Burrowscope	32	4	36
Total burrows	218	47	265

Of the 229 study burrows, 222 had known activity of flesh-footed shearwaters (Table 4). We were able to successfully identify both partners in 58% of burrows and one partner in a further 33% of burrows.

Only two burrows contained the chicks of different species, however, in both cases, flesh-footed shearwaters eventually occupied the burrow and were found incubating eggs with no other bird species in the burrow.

3.1.2 Lady Alice Island

We had burrow location descriptions for 113 burrows from Barbraud *et al.* (2014) and 105 of these burrows were found. Three other marked burrows were found randomly for which we did not have descriptions. They were marked differently and were assumed to have been part of a previous study, probably Waugh *et al.* (2014).

Sixty-one percent of the burrows monitored from 1999 to 2012 in Barbraud *et al.* (2014) study were still occupied and produced an egg. A further 8% of these burrows still showed some flesh-footed shearwater activity (adult alone in burrow).

Seventy-nine more study burrows were added to bring the total to 179 study burrows monitored for the entirety of the breeding season (Table 2). Of these, 129 burrows contained eggs (72.9%, Table 3). A further 19 burrows (not included in analysis) were added during the April trip to get closer to our aim of monitoring over 200 burrows. Of these, 10 contained live chicks that were banded, 2 contained dead chicks, 6 were empty and 1 contained sign of a chick that had recently fledged. All study burrows were located in the “LA1” colony from previous studies to maximise the chance of recapturing banded birds.

Because a lot of time was spent finding old burrows and adding in additional study burrows, fewer partners in study burrows were able to be identified. Both partners were identified in 36% of burrows and an additional 36% had one partner identified (Table 4). Of the 179 study burrows, 144 had known flesh-footed shearwater activity.

Table 2. Number of study burrows monitored in the 2016/17 breeding season, Lady Alice.

Burrow Type	Barbraud <i>et al.</i> (2014) 1999-2012 burrows	Waugh <i>et al.</i> (2014) burrows	New Burrows December 2016	Total Monitored 2016/17	New Burrows April 2017	Total marked burrows
Study burrows	97	3	79	179	19	198
Burrowscope	8	0	22	30	0	30
Total burrows	105	3	101	209	19	228

3.2 Breeding Success

One study burrow on Lady Alice Island and one burrowscope burrow on Ohinau Island monitored in December could not be found during April checks so were excluded from breeding success analysis. One more study burrow from each island was excluded from analysis because they contained chicks during April checks but no egg in December.

Breeding success here is defined as burrows with eggs that produced a chick that is likely to survive to fledging. The overall breeding success for all 2016/17 flesh-footed shearwater burrows monitored on both islands was 49.1% ($n = 196$).

3.2.1 Study Burrows

Breeding success for flesh-footed shearwaters was very similar for both islands (Table 3). On Ohinau Island, 50.7% ($n = 106$) of breeding study burrows produced a chick, while on Lady Alice Island this was marginally lower at 50.4% ($n = 65$). The cause and timing of burrow failures could not be determined in the majority of cases, however, there is some evidence that more burrows failed during the egg stage than during the chick stage.

Two burrows (one on Lady Alice Island and one on Ohinau Island) had no egg in December checks but had a chick in April checks. The burrow on Lady Alice Island was checked during the GPS tracking trip in February and no chick was present. It is therefore likely that this chick was occupying a different burrow and has shifted burrows having got lost or possibly kicked out by grey-faced petrel (*Pterodroma gouldi*).

Grey-faced petrels were present in eight burrows on Ohinau Island and six burrows on Lady Alice Island in April. A further two burrows on each island contained dead chicks with injuries consistent with grey-faced petrel attacks (bald and bleeding head or any piercing in the body). One chick was found alive with similar injuries in a burrow on Ohinau Island. No burrows with grey-faced petrels present also contained a live chick.

Of the 176 burrows on Ohinau Island that successfully produced a chick in the 2015/16 season, 83 produced a chick again meaning 47% of burrows bred successfully in two consecutive seasons.

3.2.2 Burrowscope Burrows

Ohinau Island and Lady Alice Island had similar breeding success in burrowscope burrows with rates being 40.6% ($n = 13$) and 41.4% ($n = 12$) respectively (Table 3). Overall, the 65 burrowscope burrows had a 9.5% lower breeding success than the 405 study burrows.

Table 3. Summary of breeding success and failures from all burrows on Ohinau and Lady Alice Islands.

	Ohinau Island		Lady Alice Island	
	Study burrows (<i>n</i> = 228*)	Burrowscope (<i>n</i> = 35*)	Study burrows (<i>n</i> = 177*)	Burrowscope (<i>n</i> = 30)
Burrows with eggs	209 (91.7%)	32 (91.4%)	129 (72.9%)	29 (96.7%)
Breeding success	106 (50.7%)	13 (40.6%)	65 (50.4%)	12 (41.4%)
Pre-hatching failure	18 (8.6%)	0 (0%)	17 (13.2%)	0 (0%)
Post-hatching failure	7 (3.3%)	4 (12.5%)	5 (3.9%)	0 (0%)
Failed, unknown reason	78 (37.3%)	15 (46.9%)	42 (32.6%)	17 (58.6%)

*some burrows not included in analysis

Table 4. Breakdown of burrow status for all study burrows on Ohinau and Lady Alice Islands.

Burrow Status	Ohinau Island	Lady Alice Island
Breeding (burrows with egg)		
- 0 partners		1
- 1 partner	76	65
- 2 partners	133	64
Non-breeding (burrows without egg)		
Adult/s Alone		
- 1 bird	8	11
- 2 birds	1	1
- 3 birds	2	
Pre-breeding pair	1	1
With chick in April	1	1
Total with flesh-footed shearwaters	222	144
Other species		
- Little Penguin <i>Eudyptula minor</i>		5
- Grey-faced Petrel <i>Pterodroma gouldi</i>		5
- Pycroft's Petrel <i>Pterodroma pycrofti</i>		3
- Little Shearwater <i>Puffinus assimilis</i>		3
- Sooty Shearwater <i>Puffinus griseus</i>		3
Empty	7	16
Total Burrows	229	179

3.3 Banded Birds

A total of 661 flesh-footed shearwaters were banded during the two trips to Ohinau Island (Table 5). The majority of these were caught in study burrows but banding birds on the surface at night time was overall successful. The total number of birds banded in this study on Ohinau Island is now over 1000.

Because a large portion of time was spent setting up new study burrows on Lady Alice Island, a significantly smaller number of birds were caught in study burrows. Night work was successful also with a total of 149 birds caught on the surface. When combined with the previous work carried out by Barbraud *et al.* 2014, the total number of birds banded on Lady Alice Island is also over 1000.

Table 5. Flesh-footed shearwaters banded during the 2015/16 and 2016/17 breeding seasons

Status	Ohinau Island		Lady Alice Island
	2015/16	2016/17	2016/17
Adult (study burrow)	8	344	140
Adult (surface)	82	184	145
Chick (study burrow)	177	120	84
Chick (random burrow)	0	0	6
Chick (surface)	90	13	4
Total	357	661	379

3.3.1 Recaptured Birds

Six of the eight adults banded in study burrows during 2015/16 on Ohinau Island were found in the same burrows this season. One that was not found was from a burrow where only one adult was seen so is possibly still using the same burrow. The other that was not seen had both birds from its former burrow identified so its whereabouts are unknown.

A total of 78 banded flesh-footed shearwaters were recaptured on Lady Alice Island. Sixty-five of these were in burrows while the other 13 were recaptured on the surface. Five of the recaptures were birds caught in March 2000 as adults, making these birds all now at least 22 years old.

3.3.2 Management of Records of Banded Birds and Study Burrows

Copies of the field records of all birds newly banded during our trips and any previously banded birds have been deposited with the Marine Species and Threats team, Department of Conservation, Wellington. Banding schedule records have also been deposited with the National Bird Banding Scheme managed by Department of Conservation, Wellington.

A list of all study burrows tagged on both islands and the GPS locations of each site, plus maps and relevant photos have been deposited with the Marine Species and Threats team, Department of Conservation.

4. DISCUSSION

4.1 Study Burrows

Both islands have proved to be great locations for a long-term demographic study of flesh-footed shearwaters. They are both readily accessible from the mainland with a good campsite on Ohinau Island and hut on Lady Alice Island to be based at. The open vegetation and mostly compact soils means moving around and between burrows is easy.

The previous work on Ohinau Island setting up study burrows meant more time could be spent focussing on identifying partners in burrows. No more study burrows should need to be added for the next season. A similar occupancy rate of over 90% would mean we would remain with over 200 occupied study burrows.

Because there has only been one season of monitoring on Lady Alice Island in this study, more study burrows will need to be added to bring the total number of occupied burrows to over 200. Old study

burrows from the Barbraud *et al.* (2014) monitoring that remain empty or with other species occupying them may be considered for replacement with active flesh-footed shearwater burrows. Following the next season, both islands should be at approximately the same sample size and thus better comparisons between the two populations can be made.

4.1.2 Timing of Monitoring

We unintentionally arrived on Ohinau Island three days before egg laying commenced. We arrived on Lady Alice Island on the first day an egg was laid but still approximately a week before peak laying. This was due to erroneous dates regarding breeding for flesh-footed shearwaters in the literature. This worked to our benefit in two ways. Firstly, we were able to determine the laying date of nearly all burrows and confirm that the period that flesh-footed shearwaters lay is much later than previously thought (Bell *et al.* In press). Secondly, in many cases we were able to catch the female in the burrow just after laying and before she left the male to do the first full incubation stint. This meant we were able to band and identify both partners early on in a burrow and then no longer have to disturb the burrow.

4.2 Breeding Success

Our measure of breeding success is one of the first for New Zealand colonies of flesh-footed shearwaters. An overall breeding success of 49.1% is similar to that observed in studies on Australian populations. On Woody Island, Western Australia, breeding success for flesh-footed shearwaters was measured as 40% and 53% for two consecutive seasons (Powell *et al.* 2007). Priddel *et al.* (2006) observed a 50% breeding success rate during the 2002/03 breeding season on Lord Howe Island, Eastern Australia. Reid *et al.* (2013) incorporated data from the literature with their own field studies on Lord Howe Island also and estimated breeding success for the 2008/09 season to be 60%.

Both Lord Howe and Woody Islands have Ship Rats (*Rattus rattus*) present which are known to predate the eggs and young of several species of burrowing Procellariiformes (Moors and Atkinson 1984). Both of our study islands are predator free and so could be expected to have higher breeding success. We therefore suggest that breeding success measured for this season is possibly on the lower side of what could be expected. Only 47% of birds that bred successfully in the previous season on Ohinau Island, bred successfully again which supports this theory. The cause of failed burrows is likely to be the same on both Islands as the measured breeding success was nearly identical for both islands.

Heavy rainfall from the remnants of extra-tropical cyclone Debbie may have caused some burrows to fail. In a 48-hour period from 04 - 05 April 2017 over 230mm of rainfall was measured at Castle Rock, Coromandel (closest rainfall measurement to Ohinau Island; Waikato Regional Council 2017). During that same period over 130mm of rain was recorded at Marsden Point near Whangarei (closest rainfall measurement to Lady Alice Island; Northland Regional Council 2017). Flooding of burrows during storms causing breeding failures has been identified as an increasing source of climate-related mortality for burrowing seabirds (Lavers 2015; Chambers *et al.* 2011). A small study colony of flesh-footed shearwaters ($n = 28$ pairs) at Bethells Beach on the Auckland west coast had a breeding success of 75% in 2016/17 (G. Taylor pers. comm.). The extreme rainfall event in April mainly impacted eastern parts of Northland, Auckland and Bay of Plenty (NIWA 2017). The difference in breeding success between east and west coast flesh-footed shearwater colonies therefore supports the burrow flooding hypothesis.

Grey-faced petrels are also likely to be the cause of some breeding failures on both islands. None of our study burrows with Grey-faced petrels present in April contained flesh-footed shearwater chicks. Many grey-faced petrels were observed on the surface at night time on both islands and there was evidence of chicks having been killed by them. Grey-faced petrels are known to evict the unguarded

chicks of flesh-footed shearwaters when they arrive to clean out burrows in April (Barbraud *et al.* 2014, Waugh *et al.* 2014).

4.2.1 Burrowscope Burrows

Burrowscope burrows showed considerably lower breeding success than our study burrows. This suggests that our handling of birds and hatches dug in to chambers are not having an adverse effect on breeding success. Burrows without hatches were more difficult to check so it is possible that chicks were missed in burrows. However, we refute this as burrows that were thought empty were double checked by a second person and often also checked with the probing burrows with a stick and a burrowscope to confirm their empty status.

4.2.2 Measuring Breeding Success

Two burrows (one on Lady Alice Island and one on Ohinau Island) had no egg in December checks but had a chick in April checks. It is possible that eggs were laid in these burrows after we left the islands as we did have an egg laid on the last day of checks (19 December), however, the burrow on Lady Alice Island was checked in February and did not contain a young chick. Had this check not been made in February then we would have recorded this burrow, and the burrow on Ohinau Island, as successful and thus overestimated breeding success. This issue is apparent because burrows only get checked on one day in April checks and the final status of the burrow is determined then.

4.3 Banded Birds

Recapturing six of eight adults banded on Ohinau Island in last season's study breeding in the same burrows this season was an excellent sign. Of four birds banded and fitted with GLS in 2012 on Ohinau Island, none was recovered in 2014 (Waugh *et al.* 2014). Skipping of breeding or low adult survivorship was suggested as an explanation for this. While our sample size is small, our findings suggests that many birds are breeding in consecutive seasons and not skipping breeding. Further investigation is warranted and with 342 breeding birds banded in study burrows on Ohinau Island and 193 on Lady Alice Island, more robust data will be collected in the next seasons.

Approximately one hour before the dawn exodus seemed to be the best time for catching adults in December as this is when most birds appeared on the surface being very vocal. The time of the night that chicks were seen on the surface exercising in April seemed to be random so any time after dark was the best time. Chicks spent very little time on the surface and so the only way to increase the number of chicks caught was to increase catch effort by spending more time working at night.

5. Conclusions and Recommendations

The monitoring of the flesh-footed shearwater breeding season was highly successful on both islands. With a large number of established study burrows, less time will be needed to carry out day time burrow checks in the future, and this effort can be put in to banding and recapturing birds at night. This added night effort coupled with having a large number of individuals already banded will likely mean a large sample of recaptured birds is collected. Waugh *et al.* (2014) advise that recapture efforts need to be consistent and a high proportion of individuals (>30% per annum) need to be recaptured to provide a robust mark-recapture dataset and help determine survivorship. We recommend that this becomes one of the main focuses for the next breeding season.

Ongoing and repeated monitoring of flesh-footed shearwater study burrows will be important and will help to provide better estimates of breeding success and changes over time. Our handling of birds in

study burrows does not appear to affect breeding success and so we recommend that the same method of burrow monitoring be continued. This will involve two trips, one in December/January and one in April/May. Multiple checks of burrows will be made on the first trip and only one check for the later trip.

6. ACKNOWLEDGEMENTS

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8. APPENDICES

8.1 Other bird species observed on Ohinau and Lady Alice Islands

Species	Ohinau Island	Lady Alice Island
Flesh-footed Shearwater	Hundreds of birds on surface in December. 5-10 adults seen per night in April	Hundreds of birds on surface in December. 5-10 adults seen per night in April
Sooty Shearwater	One adult banded in burrow on egg	One adult banded in burrow on egg, one chick banded in burrow in April
Fluttering Shearwater	Heard calling most nights in December	Heard calling most nights in December
Buller's Shearwater	None observed	Commonly seen flying off the coast
Little Shearwater	Seen up to six on surface most nights in December. Two chicks observed in burrows	Up to 10 birds seen most nights in December
Diving Petrel	Heard calling most nights in December. One seen on surface	None observed
Pycroft's Petrel	Not common. One adult banded and two others seen for all of December	Lots seen on surface and in burrows
Grey-faced Petrel	1-2 chicks present in burrows in December. Very common in April with 26 individuals seen on surface one night and multiple birds in burrows	A few chicks in burrows in December, very common in April on the surface and in burrows
Little Penguin	Hear calling at night sometimes. One observed overnighting in study burrow	Common
Pied Shag	Up to 34 individuals roosting in bay near camp each day	Up to 40 birds roosting in bay near camp each day
White-faced Heron	One bird seen roosting in bay near camp	None observed
Variable Oystercatcher	None observed	A pair with two chicks seen most days at West Bay
Black-backed Gull	Nest with two chicks on top of coastal rock pillar in December. Four adults often seen	Seen offshore and on beach near camp
Red-billed Gull	Flocks of up to 30 birds present when fishing boats were close to island	Large numbers seen offshore, a few birds on beach each day
Australasian Gannet	1-4 birds seen flying past island	Common offshore
Caspian Tern	None observed	1-2 birds seen offshore

Bellbird	Very common throughout whole island	Abundant
Tui	Heard twice in December	Abundant
Saddleback	None observed	Common
Fantail	Common, seen most days	Common
Kaka	Heard calling on one day	2-5 birds seen each day
Morepork	Heard most nights	Common
Kingfisher	Common throughout island	Common
Silvereye	Very common throughout whole island	Common
Welcome Swallow	Common, seen most days	Common
Grey Warbler	Common throughout island	Common
Shining Cuckoo	Heard calling about 3 times in December	Common
Australasian Harrier	Up to two individuals seen most days	2-3 birds seen each day
Dunnock	Very common throughout whole island	Common
House Sparrow	Small flocks heard around camp	None observed
Blackbird	Common throughout island	1-2 birds seen each day
Starling	Heard most days throughout island	Common
Chaffinch	Single bird heard on 4-5 occasions	Common