

**Annual Report on Project POP2011-02 Flesh-footed Shearwaters  
- population study trial and at-sea distribution -**



**Museum of New Zealand, Te Papa Tongarewa**

**Susan Waugh, Graeme Taylor**  
[Susan.waugh@tepapa.govt.nz](mailto:Susan.waugh@tepapa.govt.nz)

Data and advice provided by Andrea Booth.

**12/09/2012**

## **Abstract**

This is the annual report for the first year of a two year study of flesh-footed shearwater on three off-shore island breeding sites and foraging areas. Sites studied were Titi Island, Marlborough, Ohinau Island, Coromandel and Lady Alice Island, Northland.

Data for assessing survival rate gathered by G. Taylor and A. Booth at Betthels Beach and Lady Alice Island respectively were formatted for mark-recapture analyses to be conducted in July 2012.

Transect surveys were used to assess burrow density and map colonies. Burrow-scope surveys were used to assess burrow contents and assist in estimating the populations during the breeding season.

Locational loggers were deployed, including GPS and GLS loggers, to assess foraging patterns. Blood and feather samples were taken to determine the trophic-level of prey items by stable isotope analysis. Results for the study have yet to be determined, and will be described following a 2<sup>nd</sup> year of data gathering and analyses.

**Keywords** Flesh-footed shearwaters, effects of fishing, bycatch

## Introduction

This research into New Zealand flesh-footed shearwaters (*Puffinus carneipes*) is to assess the at-sea distribution of these seabirds and to examine how to improve estimates of population parameters. The project was commenced in December 2011, We visited sites in Marlborough, Northland and Coromandel for the 1<sup>st</sup> quarter of 2012.

Considerable information about the populations at the three study sites chosen, and a fourth at Bethells Beach, West Auckland, were available, with previous surveys of population size allowing a base-line estimate of population size to be established.

The study allows an examination of the beginning of population trends for flesh-footed shearwaters, which has previously been subject to few detailed studies. Estimates of population size established by Baker et al. (2010), enable a comparison with studies deploying a similar methodology, such as the one reported here. Baker et al. 2010 established the most important populations in New Zealand for the species, with 8 islands identified as having substantial numbers of Flesh-footed shearwaters (Table 1).

The sites selected for this study (Titi Island, Ohinau Island, Lady Alice / Mauimua) were chose for their ease of access, important for repeat surveys, and because of the history of study at the sites (Lady Alice Island). Other sites with large populations of flesh-footed shearwaters nesting were not chosen because of the extreme fragility of the substrates (especially Karewa Island) or because access or accommodation is more challenging.

The flesh-footed shearwater population in New Zealand is limited to offshore islands from Cook Strait northwards. It nests in Australia at several sites, with the population at Lord Howe Island studied in some detail. A small population (c.500 pairs) at St Paul Island in the Southern Indian Ocean is largely unstudied (BirdLife 2012, ACAP 2012). The species conservation status is listed by the IUCN as “Least Concern” due to its extensive range, large population size (over 10,000 mature individuals) and lack of evidence of rapid decline in numbers. Nationally, however, the population status has raised some concerns and was listed as “At Risk Declining” by the Department of Conservation in its most recent review of species information (Miskelly et al. 2008).

In New Zealand, flesh-footed shearwaters have been observed captured in a number of commercial longline and trawl fisheries, particularly inshore bottom longline targeting snapper and scampi trawl. In Australia, Baker & Wise (2005) estimated that around 1800 – 4500 birds were killed each year in longline fisheries between 1998 and 2002. More recent studies in the Australian zone indicate a strong overlap between the Australian fishery and the foraging range of the Lord Howe Island birds (Thalman et al. 2009, 2010).

Table 1. Summary of flesh-footed shearwater colony size (potential burrows) based on Baker et al. 2010. \* sites chosen for intensive study in this project. + Data from Taylor 2000 and G. Taylor (pers. obs.) including (+) transect surveys and assessment of extent of habitat by sighting and calls at Middle I.

<i>Island (Island group)</i>	<i>Number of potential burrows (95%CI)</i>	<i>Number of occupied burrows (95%CI)</i>
<b>Hen &amp; Chicken Islands Group</b>		
West Chicken	193 (-2 – 388)	15 (0 – 210)
Lady Alice Island / Mauimua *	2763 (2079 – 3447)	921 (237 – 1605)
Hen Island / Taranga + (1991)	0	0
Whatupuke	2941 (1767 - 4115)	1210 (36 – 2384)
Coppermine Island	2290 (1924 – 2656)	1425 ( 1059 – 1791)
<b>Mercury Islands Group</b>		
Middle Island (2003) (+)		3000 (2000-4000) pairs
Green Island	132 (82 – 182)	84 (24 – 124)
Stanley Island (1998, 2003) +	1	1
Stack NW of Stanley (1998, 2003) +	1	1
Korapuki (2003) +	< 10	< 10
Double Island (1988 – 1990) +	Fewer than 10	Fewer than 10
Red Mercury (1990 – 2003) +	0	0
Ohinau Island *	3883 (2755 – 5011)	2071 (943 – 3200)
Little Ohinau (1970s) +	< 10	< 10
<b>Eastern Coromandel Region</b>		
Karewa Island	5929 (4420 – 7438)	2561 (1052 – 4070)
Aldermen Islands (1994) +	0	0
<b>Cook Strait / Marlborough Region</b>		
Main Trio Island (Trio Islands) (1960s) +	< 10	< 10
Titi Island*	2814 (2201 – 3427)	337 (0 – 950)
<b>Islands of the West Coast of North Island</b>		
Kauwahaia Island (Bethells Beach West Auckland) (2005 – 2006) +		20
Motumahanga Island (Sugarloaf Islands) +	100-200	100 - 200

Modelling of the potential fatalities in commercial trawl and longline fisheries found that flesh-footed shearwaters were among the top ten species at risk from direct fishing impacts in New Zealand (Richard et al. 2010).

This work aims to establish a study methodology for suitable longer term research on flesh-footed shearwater populations in selected sites in New Zealand. This report describes the progress to date to achieve these aims.

## **Objectives**

The objectives of this project are:

- 1 To assess the feasibility of gaining improved estimates of key flesh-footed shearwater population parameters,
- 2 To investigate the at-sea distribution of flesh-footed shearwaters

With specific objectives to:

- i Develop a project design for a population monitoring programme suitable for estimating adult survival, juvenile survival, fecundity, and age of first reproduction of flesh-footed shearwaters;
- ii Provide recommendations on the extent of monitoring required to obtain robust estimates of adult survival, juvenile survival, and age of first reproduction of flesh-footed shearwaters;
- iii Collect detailed data on the at-sea distribution and foraging behaviour of flesh-footed shearwaters in New Zealand waters;
- iv Identify areas where flesh-footed shearwaters are at highest risk of interactions with fishing gear by analysing data collected in Specific Objective iii in relation to spatial and temporal fishing effort.

## Methods

The aims of the initial phase of field research for these sites were to:

- repeat previous transect surveys,
- to establish / work in existing study colonies, and
- to deploy locational loggers on shearwaters

We carried out transect surveys to assess the density of burrows of flesh-footed shearwaters. These surveys were conducted within discrete colonies identified in previous surveys (see Baker et al. 2010).



Figure 1. Flesh-footed shearwater GPS tracked at Titi island. See [blog.tepapa.govt.nz/2012/05/03/life-in-the-burrow](http://blog.tepapa.govt.nz/2012/05/03/life-in-the-burrow)

Transects (of 2 m width) were conducted randomly throughout each colony following the methodology described by Baker et al. 2010. We identified the colony areas by ground searches, then from a single 'backbone' ran a set of perpendicular transects at random distances along the backbone. We used the terrain to provide guidance as to the placement of the backbone, e.g. along a ridge-top. This allowed transects to be placed in a way that allowed us full coverage of any colony area, without problems of bluffs or inaccessible gullies interrupting the flow of the work. Following guidance from previous surveys (R. Cunningham pers. comm.), we maximised the number of transects, as previous work on this species had shown that higher numbers of transects enabled variance on between transect density to be better estimated, rather than conducting fewer, longer transects.

We mapped out the periphery of each colony using GPS, to establish the areas over which to apply the densities established (above). We deployed adequate effort to capture c. 50 data points to describe the periphery of each colony, as the surface area of each colony was a factor important in determining the population estimate, with transect information providing density data only.

We carried out burrow-scope surveys within each colony area, with a minimum of 30 examined per colony, and up to 500 per site. A burrow was chosen at random in the edge of the colony, and then all adjacent accessible burrows were inspected until at least 30 burrows had been surveyed.

Table 2. Summary of transects run and burrows examined by island 2012

<b>Location</b>	<b>No. colonies mapped</b>	<b>No. transects run</b>	<b>No. burrows examined</b>
Titi Island	10	62	500
Lady Alice Island	7	39	395
Ohinau Island	3	26	300

Details of the data gathered at each of the three study sites follows:

**1. Lady Alice Island / Mauimua** (Hen and Chicken Group) Northland.

**Study dates:** 28 March – 6 April 2012

**Party:** Jean-Claude Stahl (Te Papa). Raymond Thorley, Robyn Blyth, Kalin Lewis.

**Foraging locations:** We deployed 19 GLS loggers on Lady Alice Island, to define foraging areas used by the shearwaters and took feather samples from logger birds to study trophic level using stable isotope analysis. Blood samples were not taken as means of preserving the samples was unavailable.

**Transect surveys:** On Lady Alice Island, 39 transects of 11m to 120m in length, and of 2m width were run.

**Study colony:** The study colony established by A. Booth was monitored, and for all accessible nests the contents noted following burrow-scope inspection. Not all nests were accessible, as some were too long or had too many obstacles to enable the contents to be determined.

**Notes:** We carried out transect surveys to assess the density of burrows of flesh-footed shearwaters. These surveys were conducted within 7 discrete colonies identified in previous surveys (see Baker et al. 2010). We mapped out the periphery of each colony using GPS, to establish the areas over which to apply the densities established (above). We carried out burrow-scope surveys within each colony area,

with a total of 395 burrows surveyed. In each area, at least 30 burrows were inspected for their burrow contents, with the first nest randomly selected.

The timing of the visit was not optimal for assessing the total population size, nor the nesting activity in study burrows. This would have been better conducted in December or January, to allow comparison with previous studies.

Data made available by A. Booth from the study colonies, monitored for 10 years until 2011 was formatted for mark-recapture analyses in July 2012.

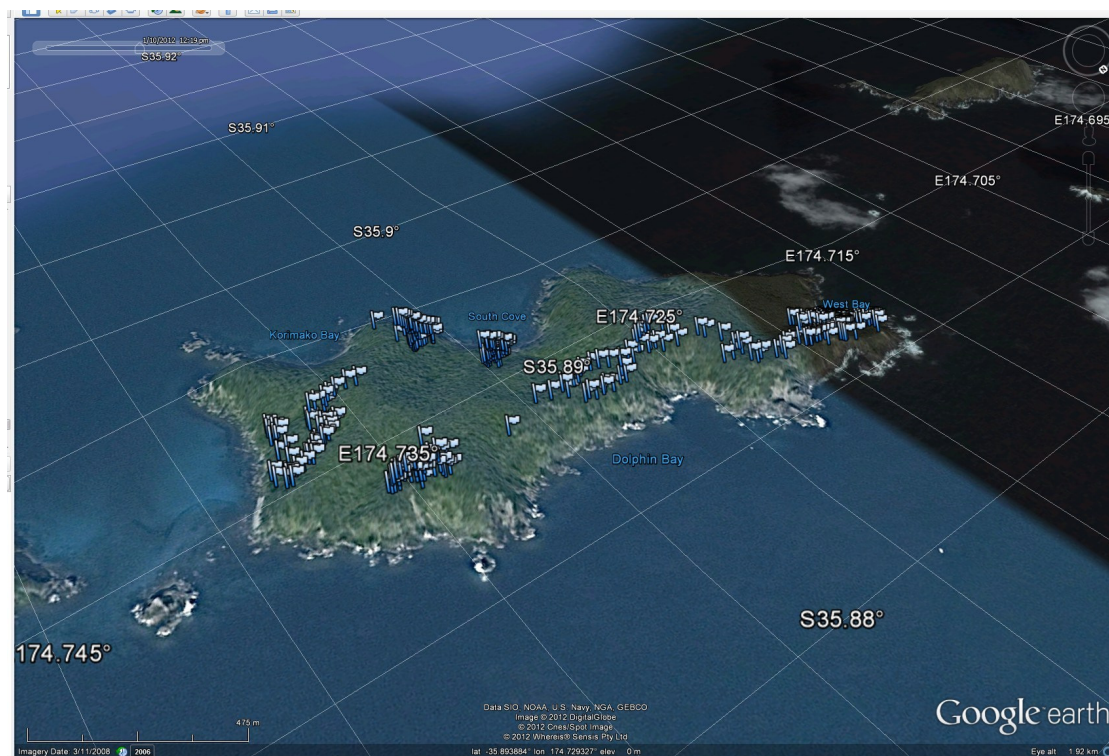


Figure 2. Lady Alice / Mauimua seen from the south. Transect lines are indicated by flags at the start and end. The mainly colonies only were surveyed in April 2012. The main study area and hut are located at the western end of the island.

## 2. Ohinau Island (Mercury Group) Coromandel

**Study dates:** 11 – 14 April 2012

**Party:** Susan Waugh, Gillian Stone, Robyn Blyth.

**Foraging locations:** We deployed 4 GLS loggers on breeding birds at 50 study burrows established during the field study. Adults were feeding independent chicks at this time, and we were unable to catch a greater number of birds due to their infrequent visits.



**Transect surveys:** On Ohinau Island, 26 transects of 12 m to 116 m long, and of 2m width were run, at the largest 3 colonies identified at the island. Two other small colonies were not assessed during this visit. We carried out transect surveys to assess the density of burrows of flesh-footed shearwaters. These surveys were conducted within 3 discrete colonies identified in previous surveys (see Baker et al. 2010). We mapped out the periphery of each colony using GPS, to establish the areas over which to apply the densities established (above). We carried out burrow-scope surveys within the two largest colony areas, with a total of 300 burrows surveyed. The first nest in each colony was selected randomly, and each adjacent nest inspected until at least 30 in any one local area had been inspected.

**Study colony:** A set of 50 nests with active breeding by flesh-footed shearwaters was identified and marked. These nests were those for which the burrow was active (ie had a chick inside) and where the nest chamber was accessible by hand or by fitting an inspection hatch. This sample was non-random. Around 30 of these had inspection hatches inserted, the remainder being accessible without hatches. Adult birds in these nests were banded.

**Notes:** The main species of petrel nesting at Ohinau Island at this period is the flesh-footed shearwater. Few sooty shearwaters were seen. Grey-faced petrels were beginning to carry out territorial activities during the visit, and interactions between the species in April may result in the deaths of flesh-footed shearwater chicks, which are unguarded at this time. Penguins were also present, though in small numbers.

The timing of the visit was not optimal for assessing population size, but the establishment of study burrows was an important step towards creating a study population for future use. In future years, a greater number of burrows is likely to be able to be located within the same colony, as nest losses during incubation would have meant a higher number of active burrows at the main colony in the landing gully than we found, arriving during chick-rearing period.



Figure 3. Ohinau Island seen from the north. Flags indicate the transect locations and locality of the two main colonies on the island. Study nests were established on the western colony, which is adjacent to the landing area and campsite.

### 3. Titi Island (Cook Strait)

**Study dates:** 9 – 17 January 2012

**Party:** Susan Waugh, Jean-Claude Stahl, Alison Burnett, Simon Hayward.

**Transect surveys:** On Titi Island, 62 transects, 19 m to 100 m long and 2 m wide, were run. We counted burrows found in 10 quadrats established by P. Gaze in the 1980s. These quadrats were established in areas where bird nesting was most dense (P. Gaze, pers. comm.). We counted all burrows, active or not, provided they could contain a bird (ie more than 50 cm long.) This was because all burrows examined with a burrow scope showed that even if a burrow entrance was full of leaves, it could contain a bird with egg.

**Foraging locations:** We deployed 6 GPS loggers on flesh-footed shearwaters, and 8 were deployed on sooty-shearwaters. Blood and feather samples were taken from logger birds and their partners, to study trophic level using stable isotope analysis. We monitored attendance at 14 nests to assess foraging trip duration. Of the data loggers retrieved (n = 8), only one contained data. Failures of the loggers were attributed to birds remaining in their burrows over a long period before leaving to feed at sea, draining the battery.

**Notes:** The study period at this site corresponded well with previous surveys (Baker et al. 2010) and hence the results will be directly comparable. This site had a predominance of sooty-shearwaters, and we found it difficult to locate a concentration of flesh-footed shearwaters to establish a larger study colony. However, once all the colonies had been identified and burrow-scoped, we found a second major concentration of flesh-footed shearwaters, which will allow the establishment of a second study area. The long incubation period of most birds (> 7 days) studied in January indicated long foraging trips were occurring. A relatively large number of unattended eggs (c. 5%) were found in both sooty and flesh-footed shearwater burrows, indicating that the 2011-12 breeding season was arduous for the birds, perhaps forcing them to abandon their eggs for periods, and to feed for longer periods than might normally occur.



Figure 4. Titi Island (Marlborough Sounds) seen from the east, with flags showing the transect lines run across the entire east face of the island. The west face is inaccessible.

#### 4. Kauwahaia Island (Bethells Beach)

Data from this site provided by G. Taylor were assessed and formatted for mark-recapture studies. G. Taylor conducted research at the site (as part of a wider study on Grey-Faced Petrels also breeding at the site). At the site, all accessible flesh-footed shearwaters had been monitored each year.

## Results

The results for the population estimates and foraging locations are yet to be analysed. Results relating to burrowscoping (occupancy) are set out in Table 3.

**Table 3 Burrow occupancy at each site – FFSW flesh footed shearwaters SSW sooty shearwater**

Location	% occupied by breeding FFSW	% occupied by breeding SSW	% abandoned eggs	% contents unknown	% occupied by other species
Titi Island	6	27	5	<1	10
Lady Alice Island	11	N/A	1.2	0	5.5
Ohinau Island	23	N/A	5	3	1

## Discussion

### *Progress to date:*

Data agreements are being developed with key researchers in the field, and analysis of available mark-recapture data is planned for July 2012, in collaboration with Dr Christophe Barbraud at CNRS, Chize, Andrea Booth (DOC) and Graeme Taylor (DOC).

The data which we could collect in the part of the 2011-12 breeding season available for the study were completed as programmed. These consisted mainly of logger deployments (3 sites), and establishment of study colonies (3 sites), and population estimates (1 site only). Loggers deployed in April 2012 will not be recovered until 2012-13 or 2013-14 breeding seasons.

Banding and recapture data have been prepared and formatted for survivorship analyses, to allow an assessment of the likely size of study populations necessary to robustly estimate changes in vital rates which may influence population trends. It should be noted, however, that the small size of the study populations from Bethells' Beach and Lady Alice / Mauimua, and sporadic nature of recaptures of burrowing birds means these datasets may not be sufficient to address this problem in isolation.

## **Acknowledgements**

This project was funded by the Department of Conservation's Conservation Services Programme ([www.doc.govt.nz/csp](http://www.doc.govt.nz/csp)) project POP2011-02. We thank John Arnould of Deakin University who assisted with providing the loggers. We are grateful to Andrea Booth, Alan Tennyson, Colin Miskelly, Barry Baker, Peter Gaze and Georgie Hedley for advice and data provided during the study. Thanks to Sarah Jamieson for edits on the document. We thank the Ngati wai Trust Board, Ngati Kuia, and Ngati Hei iwi for their consent, and assistance in delivering the programme. Thanks to those who assisted in the field, including Alison Burnett and Simon Hayward who provided their assistance as volunteers. Thank to Ellen Blake for assistance in developing the draft report.

## Appendices

### Titi Island species observed 9-17 January 2012

The following birds were seen during our visit (\* breeding = nestlings or nests found)

Blackbird

Bellbird\*

Black-backed gull

Blue penguin\*

Diving petrel\*

Fantail\*

Flesh-footed shearwater\*

Fluttering shearwater\*

Gannet

Grey warbler

Little black shag

Little pied shag

NZ Falcon (pair and chicks)\*

Pied shag

Redpoll

Reef heron

Silvereye

Sooty shearwater\*

Spotted shag\*

Starling

Welcome swallow

Yellow-crowned parakeet

## **Lady Alice Island / Mauimua species observed 28 March – 6 April 2012**

The following species were seen during our visit (\* breeding = nestlings or nests found)

Red-crowned parakeet  
Morepork  
Saddleback  
Grey Warbler  
Bellbird  
Tui  
Wood Pigeon  
Red Billed Gull  
Tuatara  
Flesh-footed shearwater\*  
New Zealand Falcon  
Pipit  
Pycroft's petrel\*  
Mynah (?)  
Tomtit  
Fantail  
Kaka  
Kingfisher  
Blue Penguin  
Gannet  
White-faced heron  
Australasian Harrier  
Grey-faced Petrel  
Welcome swallow  
Various skink, gecko sp.  
Crab (sp?)  
Bottlenose Dolphin

## Ohinau Island species observed 11-14 April 2012

The following species were seen during our visit (\* breeding = nestlings or nests found)

Flesh-footed shearwater\*  
White fronted tern  
Grey-faced petrel (pair in nest)  
Bellbird  
Fantail  
Little Shag x2  
Pied Shag x16  
NZ Falcon  
Grey warbler  
Black bird  
Black-backed gull  
Australasian Harrier  
Welcome Swallow  
Kakariki (seen only from a distance)  
Red-billed gull  
Song Thrush

At sea:

Buller's shearwater  
Flesh-footed shearwater  
Fluttering shearwater  
Storm petrel (sp?)  
Arctic skua  
Australasian gannet



## Bibliography

ACAP 2010. Flesh-footed Shearwaters are at risk from longline fisheries in Australian waters. <http://www.acap.ag/latest-news/flesh-footed-shearwaters-are-at-risk-from-longline-fisheries-in-australian-waters>. Accessed 29 June 2012.

Baker, G.B. & Wise, B.S. 2005. The impact of pelagic longline fishing on the Flesh-footed Shearwater *Puffinus carneipes* in eastern Australia. [\*Biological Conservation\* 126: 306-31](#)

Baker, B., Hedley, G. & Cunningham, R. 2010. Data collection of demographic, distributional, and trophic information on the Flesh-footed Shearwater to allow estimation of effects of fishing on population viability: 2009- 10 Field Season. Report prepared for the Ministry of Fisheries [PRO2006-01 I](#). Kettering, Australia: Latitude 42 Environmental Consultants.

Cooper, J. 2010. A brief review of the conservation status of shearwaters *Calonectris* and *Puffinus*. [ACAP AC5 Inf 15](#).

Cooper, J. & Baker, G.B. 2008. Identifying candidate species for inclusion within the Agreement on the Conservation of Albatrosses and Petrels. [Marine Ornithology 36: 1-8](#).

Dyer, P. K. 2001. Burrow occupancy by Wedge-tailed Shearwaters and Flesh-footed Shearwaters on Lord Howe Island. [Corella 26: 38-40](#).

Gaze, P. 2000. The response of a colony of sooty shearwater (*Puffinus griseus*) and flesh-footed shearwater (*P. carneipes*) to the cessation of harvesting and the eradication of Norway rats (*Rattus norvegicus*). *New Zealand Journal of Zoology* 27: 375 – 379.

Lord Howe Island Board 2009. *Draft Lord Howe Island Rodent Eradication Plan*. Lord Howe Island: Lord Howe Island Board.

Miskelly, C.M., Dowding, J.E., Elliott, G.P., Hitchmough, R.A., Powlesland, R.G., Robertson, H.A., Sagar, P.M., Scofield, R.P. & Taylor, G.A. 2008. Conservation status of New Zealand birds. *Notornis* 55(3): 117-135.

Powell, C.D.L. 2009. Foraging movements and the migration trajectory of Flesh-footed Shearwaters *Puffinus carneipes* from the south coast of Western Australia. [Marine Ornithology 37: 115-120](#).

Powell, C.D.L., Wooller, R.D. & Bradley, J.S. 2007. Breeding biology of the Flesh-footed Shearwater (*Puffinus carneipes*) on Woody Island, Western Australia. [Emu Austral Ornithology 107, 275-283](#).

Priddel, D., Carlile, N., Fullagar, P., Hutton, I. & O'Neill, L. 2006. Decline in the distribution and abundance of Flesh-footed Shearwaters (*Puffinus carneipes*) on Lord Howe Island, Australia. [\*Biological Conservation\* 128: 412-424.](#)

Richard Y, Abraham ER & Filippi D. 2011. Assessment of the risk to seabird populations from New Zealand commercial fisheries. Final Research Report for Ministry of Fisheries projects IPA2009/19 and IPA2009/20. Unpublished report held by the Ministry of Fisheries, Wellington.

Taylor, G.A. 2000. Action Plan for Seabird Conservation in New Zealand. Part B: Non-threatened Seabirds. *Threatened Species Occasional Publication* [No. 17: 2326-435.](#)

Thalmann, S.J., Baker, G.B., Hindell, M. & Tuck, G.N. 2009. Longline fisheries and foraging distribution of flesh-footed shearwaters in eastern Australia. [\*Journal of Wildlife Management\* 73: 399-406.](#)

Thalmann, S.J., Lea, M.-A., Hindell, M., Priddel, D. & Carlile, N. 2010. Provisioning in flesh-footed shearwaters (*Puffinus carneipes*): plastic foraging behavior and the implications for increased fishery interactions. [\*Auk\* 127: 140-150.](#)