

SHORT NOTE

Timing and duration of egg-laying of flesh-footed shearwater (*Puffinus carneipes*) in New Zealand

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Flesh-footed shearwaters (*Puffinus carneipes*) are a large, all dark, shearwater of the Indian and Pacific Oceans. Breeding occurs on St Paul Island, Southern Indian Ocean; on islands off the west and south coast of Australia plus Lord Howe Island; and islands around the northern coast of the North Island of New Zealand, as well as the Cook Strait. Birds forage around their breeding grounds in the Southern Hemisphere summer, migrating to the Northern Hemisphere in the austral winter. Most birds fly to the seas off Japan around June, and into the central Pacific in August, on their return to the Southern Hemisphere (Marchant & Higgins 1990; Onley & Scofield 2007; Checklist Committee 2010; Rayner *et al.* 2011).

The breeding biology of flesh-footed shearwater in New Zealand is poorly known with very limited published information. Until recently, the breeding biology of this species is better known from studies in Australia (Priddel *et al.* 2006; Powell *et al.* 2007).

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In New Zealand, egg-laying has been quoted as occurring over a 3-week period, from 21 November to 12 December (Marchant & Higgins 1990; Heather & Robertson 2005).

Determining breeding success and undertaking population estimates requires detailed knowledge of burrow occupancy, particularly of breeding birds (Priddel *et al.* 2006; Parker & Rexer-Huber 2015). Therefore, determining the precise timing of egg-laying is vital when undertaking population studies of burrowing *Procellariiformes*.

We undertook research on flesh-footed shearwaters concurrently on two islands in northern New Zealand (Fig. 1). In an attempt to catch the mean laying date and maximise work effort, field work was carried out between 30 November to 19 December 2016 on Ohinau Island, Coromandel (-36.728°S 175.881°W), and Lady Alice Island (-35.887°S 174.721°W), Hen and Chicken Islands, Whangarei. Each island had an estimated population of 2,071 and 921 (occupied burrows) respectively (Waugh *et al.* 2013).

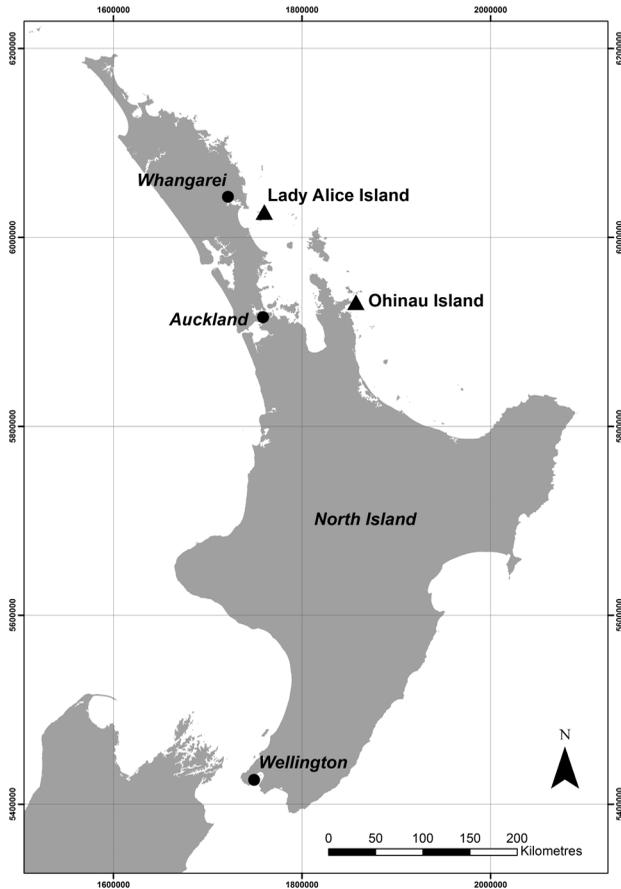


Fig. 1. Location of Ohinau and Lady Alice Islands, New Zealand.

Over 400 study burrows across both islands (215 burrows on Ohinau and 196 on Lady Alice) were checked every second day to record the laying date of flesh-footed shearwater. Birds found incubating an egg in a burrow were subsequently sexed by cloacal examination. Birds found with an enlarged cloaca were determined to be female (Warham 1990). If sex was determined as male, the laying date was recorded as the day previous, as females typically return to sea quickly after laying, with males taking the first incubation shift.

In total, we collectively determined the laying date of 236 flesh-footed shearwater eggs from both islands (167 on Ohinau, 69 on Lady Alice). The first egg was laid on 3 December (Fig. 2), with a mean lay date of 10 December. There was no difference in the mean lay date between the two islands. Fifty percent of all eggs were laid by 9 December and 90% by 13 December (Fig. 3). Egg-laying was highly synchronised, with 48% of eggs laid over three days (9–11 December), and 90% of eggs laid over 10 days (4–13 December) (Fig. 2). The last egg

recorded being laid on 19 December, however it is possible that further eggs were laid after this date, as field teams had left the islands by 20 December. At Australian colonies, Powell *et al.* (2007) recorded 81% of eggs laid over a week period (Woody Island, Western Australia), and Priddel *et al.* (2006) over six days (Lord Howe Island). Similar highly synchronised laying has been recorded in other trans-equatorial migrating *Puffinus* shearwaters (Seventy 1963; Warham *et al.* 1982).

The start of egg-laying we have recorded is later than previously published for New Zealand breeding flesh-footed shearwater (Marchant & Higgins 1990; Heather & Robertson 2005). In Western Australia, Powell *et al.* (2007) recorded egg laying to have occurred between 24 November and 6 December, with mean laying date on 2 December. At Lord Howe Island, Priddel *et al.* (2006) recorded egg-laying from 2 to 10 December, with the mean on 5/6 December. We recorded the mean egg-laying date as 10 December, suggesting that laying occurs progressively later in the eastern parts of the

Fig. 2. Percentage of flesh-footed shearwater eggs laid each day on Ohinau and Lady Alice Island, December 2016.

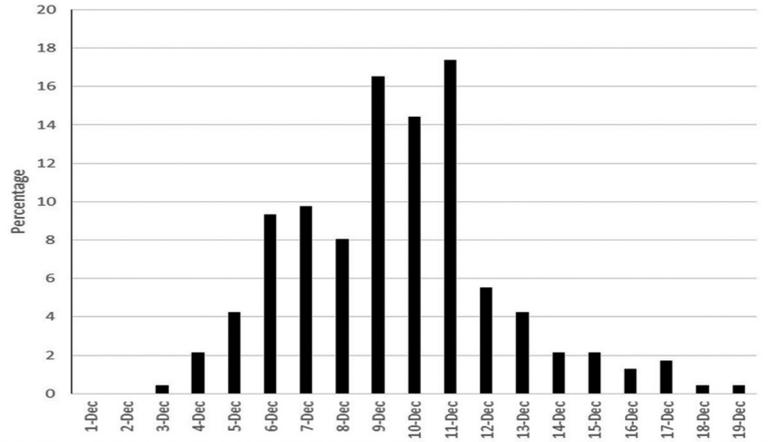
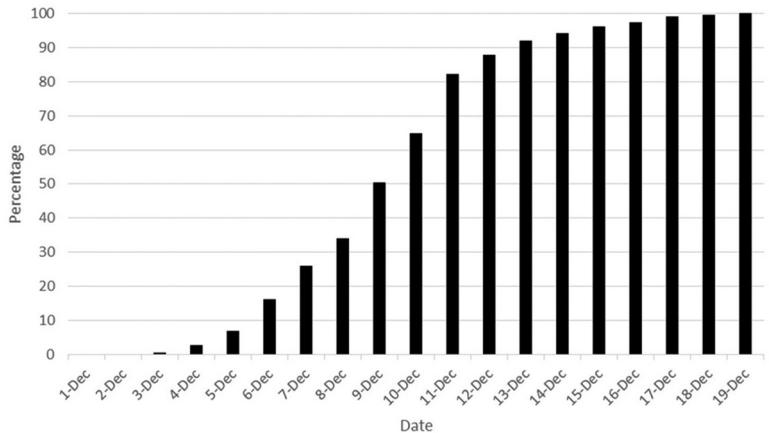


Fig. 3. Cumulative percentage of eggs laid of flesh-footed shearwater on Ohinau and Lady Alice Island, December 2016.



breeding range. In a 27-year study of flesh-footed shearwaters at the small Bethells Beach colony near Auckland, the earliest egg laid by a flesh-footed shearwater was on 30 November, but >95% of eggs are laid after 2 December (G. Taylor pers. comm.).

Confirmation that the laying period for flesh-footed shearwater in New Zealand is later than previously reported is significant in re-evaluating population estimates and trends. Lavers (2015) found many population estimates of flesh-footed shearwater from Australia to be erroneous, and pointed out that the lack of accurate demographic parameters for many populations caused historical estimates to be too high. Although Waugh *et al.* (2013) considered their data on flesh-footed shearwater to be the most complete for New Zealand *Puffinus* species, and determined a population decline, the erroneous published New Zealand laying period may require some, or all, population estimates to be revisited in light of our results.

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