

Notornis, 2020, Vol. 67: 451-458

0029-4470 © The Ornithological Society of New Zealand Inc.

Breeding of little penguins (*Eudyptula minor*), including multiple brooding, at South Bay, Kaikōura, New Zealand, 2006–2017

LINDSAY K. ROWE*

T198 24 Charles Upham Drive, Rangiora 7400, New Zealand

JODY S. WEIR

ALASTAIR G. JUDKINS

Kaikōura Ocean Research Institute Inc. (KORI), c/o Takahanga Marae,
PO Box 39, Kaikōura 7340, New Zealand

Abstract: For 11 breeding seasons, a colony of little penguins (*Eudyptula minor*) was monitored at South Bay, Kaikōura. The 106 breeding attempts from 86 pairings consisted of 68 single clutches, eight attempts made up four replacement clutches (an unsuccessful original clutch followed by a second clutch by a pair in one season), 26 attempts consisting of 13 double broods (a successful original clutch followed by a second clutch by a pair in one season), and one complex triple brood (three successful attempts by a penguin in one season, the triple brood, plus another successful attempt by its first mate after separation). The earliest laying date was 18 April for multiple brooders and 12 August for single clutch pairs. Single clutch pairs raised a mean of 1.42 fledglings/clutch. Four pairs with first clutch failures laid replacement clutches; one was successful. Seven of the 13 pairs of double brooders successfully raised the second clutch; the productivity of the 13 pairs was 2.69 fledglings/pair. The first record of a successful triple brood by little penguins was complex in that the female separated from her mate after the first brood chicks fledged, and then completed her second and third broods with a different male. Her original mate also produced a further brood with another female to complete his double brood. These four clutches laid eight eggs of which seven hatched and six chicks fledged. This may also be the first reported multiple brood with a change of mate after a successful first brood. On a colony-wide basis productivity per season was 2.36 eggs/pair, 1.80 chicks/pair, and 1.66 fledglings/pair. Previous research indicated Kaikōura birds belonged to the New Zealand Only (NZO) clade of little penguins. As double brooding and rafting are traits of the Australia and south east New Zealand (ASENZ) clade only, this classification is now questionable suggesting a mix of both clades and/or hybrids.

Rowe, L.K.; Weir, J.S.; Judkins, A.G. 2020. Breeding of little penguins (*Eudyptula minor*), including multiple brooding, at South Bay, Kaikōura, New Zealand, 2006–2017. *Notornis* 67(2): 451–458.

Keywords: *Eudyptula minor*, little penguin, breeding success, double brooding, triple brooding

INTRODUCTION

The little penguin (*Eudyptula minor*) is considered to be a species of “least concern” (BirdLife International 2018) but under the New Zealand Threat Classification it has recently been

downgraded within the “At Risk - Declining” category (Robertson *et al.* 2017). A recent review (Wilson & Mattern 2018) summarises current knowledge of little penguins and sets priorities for research and conservation in New Zealand.

Five subspecies of little penguins were recognised by Kinsky & Falla (1976) for New Zealand including

Received 25 July 2018; accepted 7 February 2020

*Correspondence: lindsay.jan.rowe@xtra.co.nz

the Cook Strait blue penguin (*Eudyptula minor variabilis*) found as far south as Kaikōura (42.43°S, 173.68°E) and Motunau Island (42.43°S, 173.68°E), and the white-flipped penguin (*E. m. albosignata*) from Banks Peninsula (42.43°S, 173.68°E) north to Motunau Island. There is continuing uncertainty about the taxonomy of little penguins, and hence, all little penguins including the white-flipped morph have been placed into a single species, *Eudyptula minor*, awaiting clarification (Gill *et al.* 2010). Recent research using mitochondrial DNA variation has determined that little penguins can be separated into two clades, the first being birds from Australia and south east New Zealand (ASENZ) and the second being mainly New Zealand Only birds from Banks Peninsula north (NZO) (Banks *et al.* 2002; Peucker *et al.* 2009; Clark *et al.* 2013; Grosser *et al.* 2015). Double brooding and rafting are considered traits of the Australia-Southeast NZ clade only (Grosser *et al.* 2015).

The main concentration of little penguins on the Kaikōura Peninsula is at South Bay on the southern side of the peninsula (42.43°S, 173.68°E) although in later years there have been isolated instances of penguins breeding on the north side of the Kaikōura Peninsula under roadside protection boulders and under a house (LKR *pers. obs.*). Until the mid-1990s, penguins at South Bay nested under boat sheds and houses, in gardens and hedges. The boat sheds were gradually removed and the Kaikōura District Council built a new seawall and jetties (I. Bradshaw *pers. comm.*). Birds that once nested and moulted under the old boat sheds began seeking shelter under houses and were prone to disturbance by household pets. As a consequence of local residents voicing concerns about a perceived decline in penguin numbers, the Department of Conservation (DOC) built a shelter in 2002 in which were placed multiple nestboxes created from inverted fish crates with a hole cut in one end (M. Morrissey, DOC, *pers. comm.*). Penguins began to breed there, as well as under the local Coastguard building, in the new marina boulder bank and in the boat park shrubbery (Fig. 1).

There are multiple threats to the survival of this colony. The boat park is used extensively each day by commercial and recreational fishers, tourism operators, charter fishing boats, and the Kaikōura Coastguard is headquartered there. The area is also used by people for recreation, mainly walking around the Kaikōura Peninsula. Predators, mainly dogs (*Canis familiaris*), have killed penguins in the area including three banded study birds in one night (Coastguard *pers. comm.*) and cats (*Felis catus*) have been seen near nests (AGJ *pers. obs.*).

A better understanding of penguin breeding within known colonies is important for establishing baselines for future comparisons. In 2006, LKR

began to study the little penguins at South Bay, Kaikōura, to determine the subspecies present, how many birds were present, and how successful they were at breeding in an area where there was much activity and many threats to their wellbeing. While little penguins are known to have multiple broods in a season (Marchant & Higgins 1990; Flemming 2013), in New Zealand it has been reported that outside Otago little penguins do not double brood (Gales 1985; Heber 2008; Agnew *et al.* 2014). Here, we report on breeding by little penguins at the South Bay colony, Kaikōura, including replacement clutches and multiple brooding and how the Kaikōura birds might fit into the two-clade scenario.



Figure 1. Extent of South Bay little penguin colony on 20 August 2012. During summer 2012–13, the marina boulder bank was replaced with new rock protection from the Coastguard building to the slipway outside the bottom-right of the photo. (Photo: Andrew Spencer).

METHODS

Monitoring and penguin handling from 2006–2017, including flipper banding and microchipping was led by LKR, a Level 3 Department of Conservation (DOC) certified bander, and later by AGJ, also a Level 3 DOC certified bander. The colony is located on grounds that are owned by Kaikōura District Council and by Kaikōura Coastguard. Both organizations support the penguin monitoring work described here.

Penguins nested in a variety of habitats: deep amongst boulders at the Marina where they were subject to splash during high storm tides and near the DOC shelter; under vegetation including flax (*Phormium* spp.) at the Boat Park and DOC shelter, and under the Coastguard building (Fig. 1). From winter 2008, purpose-built nestboxes (after Houston 1999) were placed over nests found in vegetation, at the top of the Marina boulders and under the Coastguard building. These gave the penguins

some protection from predators; no nest desertion happened as a result and penguins have re-nested in some nestboxes every year for 12 seasons until 2019–20. A season is defined as the period from 1 April (after completion of moult) to 31 March next year. Many nests could not be monitored. Nestboxes under the DOC shelter occupied by six or more pairs each year, were inaccessible, and it was not always possible to find or reach eggs or birds in the boulders nor to attribute nests or chicks to adults seen.

Visits to the colony were made approximately weekly from summer 2006 but there were occasional periods up to six weeks long in late winter when no-one was available to check on the colony. Most visits were made at dusk to record birds already present at the colony, which birds came in, and the numbers of eggs and/or chicks present at each nest. Unique numbered stainless-steel flipperbands obtained from DOC were applied to all adult birds found and to chicks about to fledge. Passive integrated transponder (PIT) tags were implanted in the necks of adults from December 2008. PIT tag readers at tunnels into the Coastguard building and the DOC shelter allowed movements of birds to be recorded at those sites between the weekly visits. All observations reported here were of pairs of banded birds on nests or in nestboxes, and the bands were read every visit to confirm which birds were on which accessible nest.

Because visits to the colony were weekly with some large gaps, recorded dates for the first sighting of eggs were often approximations. The incubation period of little penguins average about 35 days (e.g. Chiaradia & Kerry 1999; Kemp & Dann 2001; Heber *et al.* 2008; Flemming 2013) and laying of the two egg clutch usually occurs 2–4 days apart (Marchant & Higgins 1990; Kemp & Dann 2001; Heber *et al.* 2008). Therefore, laying dates for pairs of eggs have been determined as follows:

- if an egg was seen on day x and a second egg was seen the next visit, laying date = $x+1$;
- if laying occurred in an interval <8 days, the laying date is the middle of the two dates;
- if laying occurred in an interval >8 days, laying date is 35 days before hatching if known or estimated.

Brood definitions (these apply to one season):

- a successful clutch is one where at least one chick fledged;
- a single clutch is one set of eggs produced by a breeding pair in a season (which starts after moulting has finished – 1 April);

- a replacement clutch refers to a failed first clutch followed by a second clutch by the same pair which may or may not have been successful;
- a successful double brood is two successive clutches by the same pair with one or two chicks fledged from each;
- a failed double brood is two successive clutches by a given pair with one or two chicks fledged from the first and no chicks from the second laying;
- a triple brood has three successive successful clutches in the same season.

Statistical tests were carried out using routines in Microsoft Excel and at the 95% significance level.

RESULTS

Records of banded birds at the colonies indicated the adult population of little penguins seen at South Bay, Kaikōura, was approximately 30–40 individuals including non-breeders and those only seen sporadically. Most of the penguins at South Bay are the “normal” blue penguins with little, if any, white on the anterior edge of their flippers. During the study there were at least 19 birds recorded with significant white on the anterior edge to be considered white-flipped morphs. Apart from three of these birds that were seen breeding with blue-morph birds, the rest were present for a short time either moulting or as itinerants. The mixed pairs fledged one, two and seven chicks, most of which were never seen after fledging; one fledgling was seen one year later and one successfully raised four fledglings.

Not all birds were on accessible nests so we could only monitor up to 14 pairs each season. Prior to 2009–10, we had not found all nest sites hence the low numbers of pairs monitored then (Table 1); the low numbers in 2016–17 reflected some losses from a small tsunami and limited observations possible after the magnitude 7.8 Kaikōura earthquake on 14 November 2016. From 2009–10 to 2015–16, we are confident we monitored most of the accessible nests, an average of ten nesting pairs that laid 12 clutches each season. There were 106 known clutches from 86 pairings monitored over the 11 seasons (Table 1); 68 pairings were single clutches, four pairings had replacement clutches, 13 had double broods, and there was one complex triple brood (two pairings, four clutches) in 2016–2017. Most seasons over 80% of pairs successfully fledged one or more chick. The 2014–15 season was exceptional for the number of double broods with four of five attempts being successful.

Table 1. Summary of breeding attempts of little penguins, South Bay colony, Kaikōura, 2006–2017. The triple complex has been treated as if it was one pair.

Season	Nesting pairs	Clutches attempted	Single clutches		Replacement clutches		Double broods		Triple complex	Successful pairs	
			Failed	Successful	Failed	Successful	Failed	Successful	Successful	Number	%
2006–07	1	1	0	1	0	0	0	0	0	1	100
2007–08	5	6	0	4	0	0	0	1	0	5	83
2008–09	5	5	0	5	0	0	0	0	0	5	100
2009–10	8	8	0	8	0	0	0	0	0	8	100
2010–11	7	8	0	6	0	0	1	0	0	6	86
2011–12	14	17	5	6	1	0	1	1	0	7	50
2012–13	11	15	2	5	1	1	2	0	0	6	11
2013–14	11	11	2	9	0	0	0	0	0	9	82
2014–15	11	17	2	3	1	0	1	4	0	7	63
2015–16	9	9	1	8	0	0	0	0	0	8	89
2016–17	4	9	0	1	0	0	1	1	1	3	75
Total	86	106	12	56	3	1	6	7	1	65	76

Single clutches

Of the 68 single clutches laid, 52 with known lay dates and four with unknown lay dates were successful; 12 failed. Laying dates for the successful clutches were between 12 August and 17 November with a mean of 26 September ($n = 46$; 95% CL = ± 7 days). All 50 successful clutches of known size comprised two eggs; hatching averaged 1.87 chicks/pair and 1.75 chicks/pair fledged. Including failed single clutches, there was 1.91 eggs/pair, 1.55

chicks/pair (hatching rate 81%) and 1.42 fledglings/pair (fledging rate 92%); the breeding success rate (chicks/egg) was 75%.

Replacement clutches

In addition to the single clutches, there were four first clutches that failed and the same pairs laid replacements. Only one of these was successful with one chick fledging (Table 1; Table 2).

Table 2. Little penguin pairs at South Bay, Kaikōura, that laid two clutches in a season.

	Male	Female	Laying date	Eggs	Fledged	Laying date	Eggs	Fledged	Outcome
2007–08	P38217	P38219	2 September	2	2	15 December	2	2	Successful double
2010–11	P38223	P38222	3 September	2	1	12 December	2	0	Failed double
2011–12	P38223	P38222	14 August	2	2	30 November	2	2	Successful double
2011–12	P38214	P44315	-	2	1	14 November	1	0	Failed double
2011–12	P38314	P38299	-	1	0	-	1	0	Failed replacement
2012–13	P38217	P38216	12 September	2	1	27 November	2	0	Failed double
2012–13	P38258	P38269	5 October	2	0	21 November	2	1	Successful replacement
2012–13	P38273	P38222	17 September	2	2	1 December	1	0	Failed double
2012–13	P38325	P38215	3 October	2	0	-	2	0	Failed replacement
2014–15	P38217	P38216	28 July	2	2	15 November	2	2	Successful double
2014–15	P38280	P38278	23 July	2	2	5 November	2	2	Successful double
2014–15	P44317	P38299	16 July	2	2	30 October	2	0	Failed double
2014–15	P38325	P38215	-	1	0	20 October	2	0	Failed replacement
2014–15	P44345	P44358	13 August	2	2	28 November	2	2	Successful double
2014–15	P44369	P44354	27 August	2	1	6 December	2	2	Successful double
2015–16	P38217	P44315	23 May	2	2	1 October	2	0	Failed double
2015–16	P44317	P44358	6 July	2	2	28 October	2	1	Successful double

Double broods

Excluding two that were part of the triple brood, there have been 13 known double broods by same pairs at the South Bay colony; six failed and seven were successful (Table 1, Table 2). In all cases the second clutches were in the same nestbox as the first clutch, and the same adults were identified from bands when sitting on the eggs and attending to the chicks throughout the season. Double brooding pairs laid eggs as early as 23 May, 12 weeks earlier than the earliest single brood birds; the mean lay date, 7 August ($n = 13$; 95% CL = ± 21 days), was seven weeks earlier than for single broods. Mean laying dates were similar for the first clutches of failed (8 August) and successful double brooders (7 August) suggesting laying date was not a contributing factor to failure ($t = 0.005$ c.f. $t = 2.28$, $P = 0.05$, $df = 10$).

The successful and failed double brooders all laid two eggs in their first clutches. Hatching rates for first clutches of these groups were similar at 1.86 ($n = 7$) and 1.83 ($n = 6$) chicks/clutch, respectively, but the successful pairs fledged more chicks, 1.86 ($n = 7$) and 1.50 ($n = 6$) fledglings/first clutch, respectively. With respect to the second clutch, there were obvious differences with the successful brooders having the same success rate as the first clutch, 1.86 chicks/clutch, whereas, by definition, unsuccessful brooders did not fledge any chicks from the second clutch. Overall, the 13 double brood pairs produced 3.84 eggs/pair, 2.92 chicks/pair and fledged 2.69 chicks/pair, a success rate of 70% chicks/egg. The last chicks fledged in mid-March.

Two pairs had new eggs laid before the first clutch fledglings had left the nest. When visited on 27 November 2012, nestbox CG1 held both parents, P38216 and P38217, and their chick P44367 (aged 42 days) together with a new egg; 4 December P38216 and P44367 were present with the two eggs. P38216 and P38217 were still visiting the nextbox through to mid-February but there was only one egg present on 18 December and none on 8 January. The second pair, P38222 and P38273, were not present in nestbox CG5 on 4 December 2012 but it held their two large chicks (aged 44 days) and one new egg; one dirty egg was present until 27 December.

Five of the 15 birds that double brooded are known to have hatched at South Bay and first bred as 3–5 year-olds. Three double brooders were the progeny of a pair that failed once but later succeeded as a double brooder. Another successful double brooder was a product of a pair that had a failed replacement clutch in 2011–12 before one went on to have a failed double brood in 2014–15 and then completed a triple brood in 2016–17 with two different partners.

Triple brood

One complex triple brood was successfully completed in the 2016–17 season by female P38299. The earliest egg laying recorded at South Bay, 18 April, was the start of the triple brood (Table 3). After the first brood chicks fledged, P38299 separated from P44345, the partner for her first clutch, and paired with P48417 with whom she produced two further successful clutches that season each with one fledgling. Meanwhile, P44345 paired with P48466 with whom he produced a further successful two-fledgling clutch that same season. This triple brood complex laid four clutches in total, producing eight eggs of which seven hatched and six chicks fledged, the last being about 20 February, earlier than most double broods.

Table 3. A triple brood by little penguins at the South Bay colony, Kaikōura, 2016–2017. At the end of the first clutch, P38299 and P44345 separated and proceeded to have additional broods with their respective new partners, P48417 and P48466.

Female	P38299	→ P38299	P48466
Male	P44345	P48417	P44345
Laying date	18 April		
Number of eggs	2		
Hatching date	23 May		
Number of chicks	2		
Fledging date	13 July		
Number fledged	2		
Laying date		7 August	31 October
Number of eggs		2	2
Hatching date		14 September	5 December
Number of chicks		1	2
Fledging date		9 November	2 February
Number fledged		1	2
Laying date		26 November	
Number of eggs		2	
Hatching date		31 December	
Number of chicks		2	
Fledging date		20 February	
Number fledged		1	

Colony summary

As a colony over the 11 seasons (2006–2017) 82 pairings with known outcomes produced 2.36 eggs/pair, 1.80 chicks/pair and fledged 1.66 chicks/pair; hatching success 76%, fledging success 92% and breeding success 70%.

DISCUSSION

The population of little penguins at Kaikōura is about 30–40 seen during a season. Over the seven seasons from 2009–10 we monitored an average of ten pairs (range 7–14) that laid an average of 12 clutches/season. The annual variation and limits on detection in the early and later years means it was not possible to determine any trend in numbers during the study. That there was more clutches than pairs shows there was a significant number of replacement clutches laid, or there is double brooding at this colony which is contrary to the view that, in New Zealand, little penguins do not double brood outside Otago (Gales 1985; Perriman & Steen 2000; Agnew *et al.* 2014).

At Kaikōura, the majority of the annual pairings pairs, 68 of the 86 (79%), laid single clutches over the 11 seasons; 81% of clutches were successful and this is higher than for single clutches in many other New Zealand studies: Taiaroa Head 55% (Gales 1985); Matiu-Somes Island 58% (Bull 2000), 51% (Kinsky 1960); Tiritiri Matangi Island 40% (Jansen van Rensburg 2010). The success of clutches at Kaikōura was very high with 1.91 eggs laid/clutch, 1.55 chicks hatched from each clutch, and 1.42 chicks fledged/clutch. The breeding success rate of 75% is amongst the highest reported for single clutches in New Zealand which range between 3.5% at Tiritiri-Matangi (Boyer 2010) and 79% at South Westland (Braidwood 2009; Braidwood *et al.* 2011; Wilson & Mattern 2018). Productivity of these single clutches is also very high at 1.42 fledglings/pair; South Westland has the only reported higher productivity at 1.55 fledglings/pair (Braidwood 2009; Braidwood *et al.* 2011).

There were four replacement clutches (25% of failed first clutches) at Kaikōura with only one successfully fledging one chick. Replacement clutches after first clutch failures are laid at many New Zealand colonies but very rarely on the West Coast (Heber *et al.* 2008; Braidwood, 2009; Braidwood *et al.* 2011, K-J. Wilson *pers. comm.*) and rarely at Banks Peninsula (Allen *et al.* 2011). With only one fledgling from four replacement nests at Kaikōura, the success rate was lower than two North Island colonies; Matiu-Somes Island: five fledglings for seven replacements (Kinsky 1960), four fledglings from four replacements (Bull 2000); Tiritiri Matangi Island: three fledglings from seven replacements (Jansen van Rensburg 2010), but was better than at Taiaroa Head where all nine replacements failed (Gales 1985).

At South Bay between 2006 and 2017, 13 (15%) pairs had double broods of which seven second broods were successful. Double brooding has been reported in New Zealand for little penguins attributed to the ASENZ clade at Oamaru (45.11°S, 170.97°E; 370 km south west of Kaikōura) (Perriman

et al. 2000; Johannesen *et al.* 2003; Agnew *et al.* 2014) and Taiaroa Head (45.82°S, 170.75°E; 440 km south west of Kaikōura) (Gales 1985; Perriman & Steen 2000; Perriman *et al.* 2000)-but not at any other colony. The number of pairs double brooding was low compared to Oamaru (27%, Agnew *et al.* 2014) and Taiaroa Head (30%, Gales 1985; 0–48%, Perriman & Steen 2000). Seasonal productivity at Kaikōura for all double brooders was 2.69 fledglings/pair, a rate slightly higher than the 2.5 chicks/pair that Johannesen *et al.* (2003) measured at Oamaru but their analysis included replacement clutches.

Overall productivity at Kaikōura was 1.66 fledglings/pair which is lower than 1.89 fledglings/pair reported for Oamaru where there was about twice as many double brooders (Agnew *et al.* 2014). The fledging success rate was similar to some Australian colonies: Bowen Island, 1.6 fledglings/pair with 14% double brooders (Fortescue 1999), and North Harbour, Sydney, 1.71 fledglings/pair with 24% double brooders (Priddel *et al.* 2008).

The triple brood by P38299 in 2016–17 appears to be very unusual as there are no published records of a penguin successfully rearing three broods in one season. The very early laying dates of the first clutch, 17 April, meant there was plenty of time to fledge the three consecutive broods. Three clutches, likely to have been replacements after unsuccessful attempts, have been reported for 12 of 1,050 breeding attempts by Australian little penguins but the final outcome was not given (Nisbet & Dann 2009). Johannesen *et al.* (2003) reported seven pairs laying three clutches at Oamaru but none managed to raise all three broods. Similarly, Perriman *et al.* (2000) report pairs laying three clutches but does not specify the site(s) or outcomes. Thus, this is the first report of a successful triple brood known to us. This triple brood is also unique in that birds that have separated after a successful brood have not been reported to have produced further broods that season. After their separation P38299 and P44345 had two and one additional broods with new partners, respectively.

Gill *et al.* (2010) placed all little penguins including the white-flipped morph into a single species, *Eudyptula minor*, awaiting clarification. If the simplistic definition of a species “is a group of organisms that share a genetic heritage, are able to interbreed, and to create offspring that are also fertile” (Biologydictionary.net 2019) is applicable, then a pair of blue- and white-flipped morphs at Kaikōura that have fledged chicks that successfully raised a further generation helps support the inclusion of the white flipped morph in the New Zealand taxon.

A study of mitochondrial DNA variation (Banks *et al.* 2002) determined that little penguins could

be separated into two clades, the first being birds from Australia and Otago (now called the ASENZ clade), and the second the rest of New Zealand (NZO clade); there were no Kaikōura birds in that analysis. A subsequent study using more specimens but, again, without Kaikōura birds, confirmed the 2-clade scenario but noted that both clades were present at Oamaru (Banks *et al.* 2008). Later studies confirmed that ASENZ birds only were present at the Catlins and Otago Peninsula and that both clades were present at Oamaru (Banks *et al.* 2008; Peucker *et al.* 2009; Clark *et al.* 2013). Birds sampled north of Oamaru have been almost entirely NZO with the exceptions of one ASENZ bird found at Banks Peninsula (Clark *et al.* 2013) and one at Motunau Island (Peucker *et al.* 2009); a sample of six Kaikōura birds were all placed in the NZO clade (Peucker *et al.* 2009). Later work (Grosser *et al.* 2015) found a beach-wrecked specimen from Kaikōura had Australian lineage but it was not known whether that was vagrant or a Kaikōura colony penguin.

We now have evidence of double brooding of little penguins at Kaikōura, a trait believed to only belong to the ASENZ clade of little penguins (e.g. Agnew *et al.* 2014; Grosser *et al.* 2015). That clade is also known to have penguins congregate near shore in rafts after dusk, to swim ashore as groups and walk to their nesting sites whereas NZO birds do not (Grosser *et al.* 2015). At Kaikōura, penguins are heard calling offshore after dusk and then come ashore along set paths in small groups, up to ten at the DOC shelter and six at the Coastguard. Therefore, based on these two factors, the Kaikōura penguin colony appears to have a substantial component from the ASENZ clade.

There has been one ASENZ bird found at Motunau Island, 87 km south-west of South Bay (Peucker *et al.* 2009), another at Banks Peninsula 150 km to the south west (Clark *et al.* 2013), and P37188 banded in Oamaru, an ASENZ stronghold, in 2007 arrived at South Bay where it paired with a local penguin for three seasons producing at least two chicks (LKR *unpubl. data*). Together, these suggest there could be northward expansion of ASENZ birds and that the Kaikōura Peninsula might be a transition zone of hybridisation between the two clades. Peucker *et al.* (2009) suggested a focus for future work could be sampling from coexisting sites to see if one clade is displacing the other and/or hybridising. It would seem that the South Bay colony could be a good candidate for this work as the total population sample is about 30–40 adult birds with up to 20 chicks hatched in a season.

A second, but perhaps more difficult, focus might be to find a simple physical method to characterise the clades. While there is a clear separation of the clades and the possibility of

relating that to subspecies, at sites where they coexist there does not seem to be a practical way for the casual observer to visually determine the clades from close up, or at a distance. This lack of easy separation might therefore provide a case for maintaining the status quo of lumping all New Zealand little penguins into one *Eudyptula minor* taxon.

ACKNOWLEDGEMENTS

We wish to acknowledge: Mike Morrissey and Ian Bradshaw for information regarding the history of South Bay area; the Kaikōura Coastguard for access to their building; the Kaikōura District Council for funding aspects of the work; and the many helpers that assisted with collecting our observations. We also express our grateful thanks to Kerry-Jayne Wilson and the editor whose efforts greatly improved this manuscript. This work was carried under permits of the DOC New Zealand National Bird Banding Scheme.

LITERATURE CITED

- Agnew, P.; Houston, D.; Lalas, C.; Wright, J. 2014. Variation in reproductive performance of little penguins (*Eudyptula minor*) attributable to double brooding. *Journal of Ornithology* 155: 101–109.
- Allen, W.J.; Helps, F.W.; Molles, L.E. 2011. Factors affecting the breeding success of the Flea Bay white-flipped penguin (*Eudyptula minor albosignata*) colony. *New Zealand Journal of Ecology* 35: 199–208.
- Banks, J.C.; Mitchell, A.D.; Waas J.R.; Paterson A.M. 2002. An unexpected pattern of molecular divergence with the blue penguin (*Eudyptula minor*) complex. *Notornis* 49: 29–38.
- Banks, J.C.; Cruickshank, R.J.; Drayton, G.M.; Paterson, A.M. 2008. Few genetic differences between Victorian and Western Australia blue penguin. *New Zealand Journal of Zoology* 35: 265–270.
- Biologydictionary.net (eds) 2019. Species. *Biologydictionary.net*. <https://biologydictionary.net/organ/>. Accessed 7 March 2014.
- BirdLife International. 2018. Species factsheet: *Eudyptula minor*. Downloaded from <http://www.birdlife.org> on 10 May 2018.
- Boyer, A-S. 2010. Microbial infection of avian eggs: A threat to all synchronously incubating species? Case study of New Zealand's little blue penguin (*Eudyptula minor*). MSc thesis. Massey University, Auckland.
- Braidwood, J. 2009. Breeding biology and threats to the blue penguin (*Eudyptula minor*) in South Westland, New Zealand. Master of International

- Nature Conservation thesis, Lincoln University.
- Braidwood, J.; Kunz, J.; Wilson, K-J. 2011. Effect of habitat features on the breeding success of the blue penguin (*Eudyptula minor*) on the West Coast of New Zealand. *New Zealand Journal of Zoology* 38: 131–141.
- Bull, L. 2000. Fidelity and breeding success of the blue penguin *Eudyptula minor* Mitiu-Somes Island, Wellington, New Zealand. *New Zealand Journal of Zoology* 27: 291–298.
- Chiaradia, A.F.; Kerry, K.R. 1999. Daily nest attendance and breeding performance in the little penguin *Eudyptula minor* at Phillip Island, Australia. *Marine Ornithology* 27: 13–20.
- Clark, J.A.; Banks, J.C.; Waas, J.R. 2013. Economical genotyping of little blue penguin (*Eudyptula minor*) clades from feather-based DNA. *New Zealand Journal of Ecology* 37: 146–150.
- Flemming, S.A. 2013. Little penguin. In: Miskelly, C.M. (ed.) *New Zealand Birds Online*. www.nzbirdsonline.org.nz.
- Fortescue, M. 1999. Temporal and spatial variation in breeding success of the little penguin *Eudyptula minor* on the east coast of Australia. *Marine Ornithology* 27: 21–28.
- Gales, R. 1985. Breeding seasons and double brooding of the little penguin *Eudyptula minor* in New Zealand. *Emu* 85: 127–130.
- Gill, B.J.; Bell, B.D.; Chambers, G.K.; Medway, D.G.; Palma, R.L.; Scofield, R.P.; Tennyson, A.J.D.; Worthy, T.H. 2010. *Checklist of the birds of New Zealand, Norfolk and Macquarie Islands, and the Ross Dependency, Antarctica*. 4th ed. Wellington, Ornithological Society of New Zealand and Te Papa Press. 210 pp.
- Grosser, S.; Burrige, C.P.; Peucker, A.J.; Waters, J.M. 2015. Coalescent modelling suggests recent secondary-contact of cryptic penguin species. *PLoS ONE* 10(12): e0144966. doi: 10.1371/journal.pone.0144966.
- Heber, S.; Wilson, K-J.; Molles, L. 2008. Breeding biology and breeding success of the blue penguin (*Eudyptula minor*) on the West Coast of New Zealand's South Island. *New Zealand Journal of Zoology* 35: 63–71.
- Houston, D.M. 1999. The use of nest boxes for blue penguins (*Eudyptula minor*). *Ecological Management* 7: 7–11.
- Jansen van Rensburg, M. 2010. Parasitism, disease and breeding ecology of little blue penguins (*Eudyptula minor*) on Tiritiri Matangi Island, New Zealand. MSc. Thesis in Conservation Biology. Massey University, Auckland.
- Johannesen, E.; Houston, D.; Russell, J. 2003. Increased survival and breeding performance of double brooders in little penguins *Eudyptula minor*, New Zealand: evidence for individual bird quality? *Journal of Avian Biology* 34: 198–210.
- Kemp, A.; Dann, P. 2001. Egg size, incubation periods and hatching success of little penguins, *Eudyptula minor*. *Emu* 101: 249–253.
- Kinsky, F.C. 1960. The yearly cycle of the northern blue penguin (*Eudyptula minor novaehollandiae*) in the Wellington Harbour area. *Records of the Dominion Museum* 3: 145–218.
- Kinsky, F.C.; Falla, R.A. 1976. A subspecific revision of the Australasian blue penguin (*Eudyptula minor*) in the New Zealand area. *National Museum of New Zealand Records* 1: 105–126.
- Marchant, S.; Higgins, P.J. 1990. *Eudyptula minor* little penguin. *Handbook of Australian, New Zealand and Antarctic birds* Vol. 1. Oxford University Press, Melbourne. pp. 246–259.
- Nisbet, I.C.; Dann, P. 2009. Reproductive performance of little penguins *Eudyptula minor* in relation to year, age, pair-bond duration, breeding date and individual quality. *Journal of Avian Biology* 40: 296–308.
- Perriman, L.; Houston, D.; Steen, H.; Johannesen, E. 2000. Climate fluctuation effects on breeding of blue penguins (*Eudyptula minor*). *New Zealand Journal of Zoology* 27: 261–267.
- Perriman, L.; Steen, H. 2000. Blue penguin (*Eudyptula minor*) nest distribution and breeding success on Otago Peninsula, 1992 to 1998. *New Zealand Journal of Zoology* 27: 269–275.
- Peucker, A.J.; Dann, P.; Burrige, C.P. 2009. Range-wide phylogeography of the little penguin (*Eudyptula minor*): evidence of long-distance dispersal. *The Auk* 126: 397–408.
- Priddel, D.; Carlile, N.; Wheeler, R. 2008. Population size, breeding success and provenance of a mainland colony of little penguins (*Eudyptula minor*). *Emu* 108: 35–41.
- Robertson, H.A.; Baird, K.; Dowding, J.E.; Elliot, G.P.; Hitchmough, R.A.; Miskelly, C.M.; McArthur, N.; O'Donnell, C.J.; Sagar, P.M.; Scofield, R.P.; Taylor, G.A. 2017. Conservation status of New Zealand birds. *New Zealand Threat Classification Series* 19. Department of Conservation, Wellington. 23 p.
- Wilson, K-J.; Mattern, T. 2018. Little (blue) penguin/korora (*Eudyptula minor*). In: Mattern, T.; Wilson, K-J. 2018. *New Zealand penguins - current knowledge and research priorities*. Report compiled for Birds New Zealand, Wellington. pp. 36–72.