Notornis, 2017, Vol. 64: 48-51
0029-4470

SHORT NOTE

Confirmation of the extinction of South Georgian diving petrels (*Pelecanoides georgicus*) on Enderby Island

JOHANNES H. FISCHER
School of Biological Sciences, Victoria University of Wellington, PO Box 600, Wellington 6140, New Zealand

FREYDIS O. HJORSVARSDOTTIR
Department of Conservation, PO Box 10420, Wellington 10420, New Zealand

JOHANNA A. HISCOCK
Murikihu District Office, PO Box 743, Invercargill 9840, New Zealand.

IGOR DEBSKI
GRAEME A. TAYLOR
Department of Conservation, PO Box 10420, Wellington 10420, New Zealand

HEIKO U. WITTMER
School of Biological Sciences, Victoria University of Wellington, PO Box 600, Wellington 6140, New Zealand

Similar to most burrowing Procellariiformes in New Zealand, diving petrels (*Pelecanoides spp.*) do not appear to coexist with introduced mammals (Taylor 2000; Holdaway *et al*. 2003). All four extant diving petrel taxa (northern diving Petrel [*P. urinatrix urinatrix*], southern diving petrel [*P. u. chathamensis*], Subantarctic diving petrel [*P. u. exsul*; hereafter SubDP] and South Georgian diving petrel [*P. georgicus*; hereafter SGDP]) have experienced substantial population declines, predominantly due to predation from introduced mammals (Marchant & Higgins 1990, Taylor 2000). The SGDP, which has a circumpolar distribution, has experienced particularly steep declines in New Zealand, where it is a foredune-breeding specialist (Fischer *et al*. in press). SGDP colonies are considered extinct on the Otago Peninsula (Sandfly Bay), Stewart Island (Mason Bay), the Auckland Islands (Enderby and Dundas Island) and the Chatham Islands (Marchant & Higgins 1990; Worthy 1998; Taylor 2000; Holdaway *et al*. 2003; Wood & Briden 2008). The only known SGDP colony in New Zealand now remains in the foredunes of the Sealers Bay on Codfish Island (Whenua Hou), with an estimated population size of 150 individuals (Wood & Briden 2008; Taylor 2013; Fischer *et al*. 2017, in press). In recognition of its precarious population size, the New Zealand conservation status of the SGDP is

Received 28 January 2017; accepted 7 February 2017
Correspondence: *johannesfischer@live.nl.*

considered Nationally Critical (Robertson *et al*. 2013).

Some uncertainty, however, remains as to the status of the SGDP on Enderby Island (Taylor 2000). Introduced mammals (mice [*Mus musculus*], rabbits [*Oryctolagus cuniculus*], and cattle [*Bos taurus*]) were eradicated from Enderby Island in 1993 (Torr 2002). Furthermore, while Procellariiformes are extremely philopatric (Warham 1996), they have been shown to rapidly (re)colonize areas after eradication of introduced mammals (Ismar *et al*. 2014). There had been no recent dedicated surveys for SGDPs on Enderby Island, and the potential persistence / reestablishment of the species would be of great conservation importance. Outlined in this short note are the results of a survey we undertook to reassess the status of the SGDP at Enderby Island.

We searched for Procellariiforme burrows in the dunes of Sandy Bay (-50.500°, 166.285°), Enderby Island, and subsequently identified their occupants using protocols developed for SGDPs on Codfish Island (Fischer 2016). We conducted surveys each day and night between 12 and 22 December 2016 when diving petrels should be nesting (Payne & Prince 1979; Marchant & Higgins 1990; Fischer *et al.* 2017, in press). Survey efforts were limited to the dunes of Sandy Bay (200 m x 900 m), because SGDPs in New Zealand are considered dependent on this habitat (Fischer *et al.* in press). Surveys were completed during daylight hours by two observers working 10 m apart until the entire dunes of Sandy Bay were covered. We marked burrows with temporary markers and reflectors and recorded their GPS locations. Stick palisades were placed in burrow entrances to assess activity patterns (Johnston *et al*. 2003; Fischer *et al*. 2017, in press). We checked these palisades daily ($n = 9$), and to account for false positives, we only considered burrows with three or more records as active (Fischer *et al*. 2017, in press).

Detected burrows were revisited at night (2300 h to 0200 h; Fischer *et al.* 2017) and a variety of techniques were used to identify the occupants. We used playback calls of various Procellariiformes that are presumed to breed at Enderby Island (Payne & Prince 1979; Taylor 2000; Heather & Robertson 2015): SGDP (calls sourced from Codfish Island), SubDP, white-headed petrel (*Pterodroma lessonii*), grey-backed storm petrel (*Garrodia nereis*), white-faced storm petrel (*Pelagodroma marina*), black-bellied storm petrel (*Fregetta tropica*), Antarctic prion (*Pachyptila desolata*), and fulmar prion (*Pachyptila crassirostris*). In addition, we used burrow traps specifically designed for diving petrels (length = 30 cm, diameter = 8 cm; Fischer *et al.* in press). We deployed a maximum of 10 burrow traps per night and trapped for a cumulative total of 86 trap hours spread over seven nights. Once one of the occupants of a detected burrow was identified no further trapping efforts were made at that burrow. For burrows that were not suitable for trapping, supportive evidence (e.g., feathers in burrows, or burrow entrance size) was used to infer identification. Finally, we also spotlighted for Procellariiformes with a handheld torch (500 lm) between 2300 h and 0200 h on seven nights to identify species away from detected burrows (Crockett 1994; Ismar *et al.* 2015). We only attempted to ground diving petrels (for identification), while we let other burrowing petrel species pass overhead. Once captured, we used bill shape, placement of paraseptal process, tail shape, outer primary coloration and extent of collar to identify diving petrels to species and subspecies level (Murphy & Harper 1921; Payne & Prince 1979; Fischer 2016). We also recorded the state of brood patches to infer breeding status (Rayner *et al.* 2013).

We detected 18 Procellariiforme burrows at Sandy Bay, of which 12 were actively used (Fig. 1). Ten burrows were occupied by SubDPs and 1 by white-headed petrels. The occupants of 1 burrow remained unidentified. SGDPs were not confirmed in any of the burrows detected. The occupants of 9 SubDP burrows were identified through capture with burrow traps, while the occupants of the remaining SubDP burrow were identified using playback. The occupants of the white-headed petrel burrow were identified through supporting evidence (25 x 25 cm burrow entrance and large (length = 10 cm), pure white feathers present in the burrow). Stick palisades showed that most (mean = 71.7%; *se* = 6.2%) SubDP burrows were active every monitoring night. The white-headed petrel burrow showed activity on 66.7% of monitoring nights. In addition, a variety of Procellariiformes were spotlighted flying overhead: white-headed petrel (mean = 3.20; *se* = 0.57 individuals/h), unidentified diving petrels (mean = 1.09; *se* = 0.43), grey-backed storm petrel (mean = 0.96; *se* = 0.41) and black-bellied storm petrel (mean = 0.22; *se* = 0.13). Only one bird was caught, which was subsequently identified as a SubDP. This individual and all SubDPs captured with burrow traps ($n = 12$) showed a fully developed, bare brood patch.

Our results indicate that SubDPs breed, at low densities, in the Sandy Bay dunes. Both stick palisade records at burrows, showing activity on most monitoring nights, and well developed brood patches, suggest that the SubDPs were tending either eggs or young chicks in mid-December (Marchant & Higgins 1990), mirroring the SubDP breeding cycle reported from South Georgia (Payne & Prince 1979). Claims of southern diving petrels co-occurring with SubDPs at Enderby Island have also been made (Murphy & Harper 1921). We did not detect any southern diving petrels in the dunes

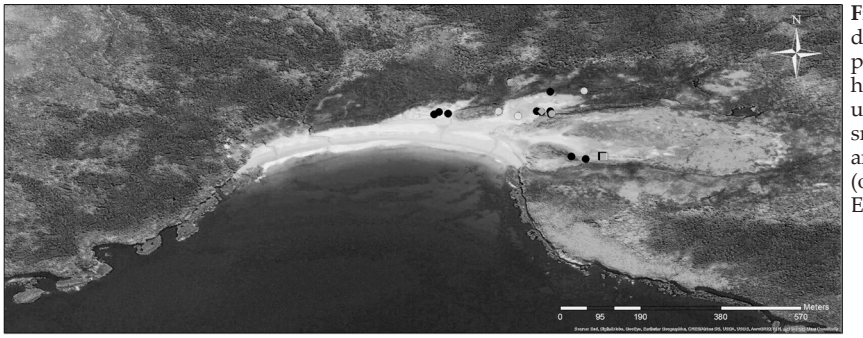

Fig. 1. Distribution of detected Subantarctic diving petrel (filled circle), white-headed petrel (filled square), unidentified (open diamond), small inactive (open circle) and large inactive burrows (open square) at Sandy Bay, Enderby Island.

of Sandy Bay, but we cannot exclude the possibility that this subspecies coexists with SubDPs on Enderby Island outside the dunes.

We did not detect any SGDPs in the dunes of Sandy Bay with any monitoring techniques, confirming previous observations suggesting that the species is indeed extinct on Enderby Island. The SGDP was probably extirpated from Enderby Island by the activities of introduced mammalian species. For example, rabbits and cattle probably changed dune vegetation, reduced the dune dynamics (Torr 2002) on which the SGDPs depended (Fischer *et al*. in press), and trampled SGDP burrows (Taylor 2000). Furthermore, mice have been shown to reduce the breeding success of various larger Procellariiformes (Cuthbert *et al*. 2013). The presence of SubDPs in the dunes of Sandy Bay, contrasting with the absence of SGDPs, can be explained by the wider range of SubDP breeding habitats (Payne & Prince 1979) allowing this species to be more resilient. SGDP are likely to be extinct on Dundas Island as well, where the species was probably extirpated by New Zealand sealions (*Phocarctos hookeri*) trampling their burrows (Taylor 2000). While no recent surveys targeting SGDPs have been conducted on Dundas Island, sealions are still very prevalent (Robertson & Chilvers 2011). The foredunes of Codfish Island thus indeed appear to harbour the last remaining colony of the SGDP in New Zealand, underlining the importance of this colony.

ACKNOWLEDGMENTS

We are grateful to Thomas Burns, Rachael Gray, Rebecca French, Sarah Michael, and Chris Muller for their support in the field. We thank Johannes Chambon and Paul Sagar for improving previous versions of this manuscript.

LITERATURE CITED

Crockett, D.E. 1994. Rediscovery of Chatham Island taiko *Pterodroma magenta*. *Notornis 41*: 49-60.

Cuthbert, R.J.; Louw, H.; Lurling, J.; Parker, G.; Rexer-Huber, K.; Sommer, E.; Visser, P; Ryan, P.G. 2013. Low burrow occupancy and breeding success of burrowing petrels at Gough Island: a consequence of mouse predation. *Bird Conservation International 23*: 113-124.

Fischer, J.H. 2016. *Ecology, Taxonomic Status, and Conservation of the South Georgian Diving Petrel (*Pelecanoides georgicus*) in New Zealand.* MSc thesis, Victoria University of Wellington, New Zealand.

Fischer, J.H.; Debski, I.; Taylor, G.A.; Wittmer, H.U. 2017 A. Assessing the suitability of non-invasive methods to monitor interspecific interactions and breeding biology of the South Georgian diving petrel (*Pelecanoides georgicus*). *Notornis 64:* 13-20.

Fischer, J.H.; Debski, I.; Taylor, G.A.; Wittmer, H.U. In press. Nest-site selection of South Georgian Diving Petrels on Codfish Island (Whenua Hou), New Zealand: implications for conservation management. *Bird Conservation International*.

Heather, B.; Robertson, H. 2015. *The field guide to the birds of New Zealand*. Auckland, Penguin Random House.

Holdaway, R.N.; Jones, M.D.; Athfield, N.R.B. 2003. Establishment and extinction of a population of South Georgian diving petrel (*Pelecanoides georgicus*) at Mason Bay, Stewart Island, New Zealand, during the late Holocene. *Journal of the Royal Society of New Zealand 33*: 601-622.

Ismar, S.M.H.; Baird, K.A.; Gaskin, C.P.; Taylor, G.A.; Tennyson, A.J.D.; Rayner, M.J.; Bettesworth, D.; Fitzgerald, N.; Landers, T.J.; Imber, M.J. 2014. A case of natural recovery after the removal of invasive predators – community assemblage changes in the avifauna of Burgess Island. *Notornis 61:* 188-195.

Ismar, S.M.H.; Gaskin, C.P.; Fitzgerald, N.B.; Taylor, G.A.; Tennyson, A.J.D.; Rayner, M.J. 2015. Evaluating on-land capture methods for monitoring a recently rediscovered seabird, the New Zealand storm-petrel *Fregetta maoriana*. *Marine Ornithology 43:* 255-258.

Johnston, R.B.; Bettany, S.M.; Ogle, R.M.; Aikman, H.A.; Taylor, G.A.; Imber, M.J. 2003. Breeding and fledging behaviour of the Chatham Taiko (Magenta Petrel) *Pterodroma magentae* and predator activity at burrows. *Marine Ornithology 31*: 193-197.

Marchant, S.; Higgins, P.J. 1990. *Handbook of Australian, New Zealand & Antarctic Birds*. Vol. 1 Ratites to ducks: Part A, Ratites to petrels. Melbourne, Oxford University Press.

Murphy, R.C.; Harper, F. 1921. A review of the diving petrels. *Bulletin of the American Museum of Natural*

History 44: 496-554.
Payne, M.R.; Prince, P.A. 1979. Identification and breeding biology of the diving petrels *Pelecanoides georgicus* and *P. urinatrix exsul* at South Georgia. *New Zealand Journal of Zoology 6:* 299-318.
Rayner, M.J.; Gaskin, C.P.; Stephenson, B.M.; Fitzgerald, N.B.; Landers, T.J.; Robertson, B.C.; Scofield, R.P.; Ismar, S.M.H.; Imber, M.J. 2013. Brood patch and sex-ratio observations indicate breeding provenance and timing in New Zealand storm-petrel *Fregetta maoriana*. *Marine ornithology 41*: 107-111.
Robertson, B.C.; Chilvers, B.L. 2011. The population decline of the New Zealand sea lion *Phocarctos hookeri*: a review of possible causes. *Mammal Review 41*: 253-275.
Robertson, H.A.; Dowding, J.E.; Elliott, G.P.; Hitchmough, R.A.; Miskelly, C.M.; O'Donnell, C.F.J.; Powlesland, R.G.; Sagar, P.M.; Scofield, R.P.; Taylor, G.A. 2013. Conservation status of New Zealand birds, 2012. *New Zealand Threat Classification Series 4.* Wellington, Department of Conservation.
Taylor, G.A. 2000. *Action Plan for Seabird Conservation in New Zealand*. Wellington, Department of Conservation.
Taylor, G.A. 2013. South Georgian diving petrel. In Miskelly, CM. (*ed.*) *New Zealand Birds Online*. www.nzbirdsonline.org.nz (downloaded on 02 January 2017).
Torr, N. 2002. Eradication of rabbits and mice from Subantarctic Enderby and Rose Islands. *Turning the tide: the eradication of invasive species. IUCN SSS Invasive Species Specialist Group, Gland, Switzerland*, 319-328.
Warham, J. 1996. *The behaviour, population biology and physiology of the petrels*. London & San Diego, Academic Press.
Wood, J.R.; Briden, S. 2008. South Georgian diving petrel (*Pelecanoides georgicus*) bones from a Maori midden in Otago Peninsula, New Zealand. *Notornis 55*: 46-47.
Worthy, T.H. 1998. Fossils indicate *Pelecanoides georgicus* had large colonies at Mason Bay, Stewart Island, New Zealand. *Notornis 45:* 229-246.

Key words South Georgian diving petrel; *Pelecanoides georgicus*; common diving petrel; *Pelecanoides urinatrix*; Enderby Island