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SHORT NOTE

Acoustic attraction system draws in competing seabird species

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Seabirds are among the most threatened taxa on the planet (Croxall *et al*. 2012,) and are affected by a wide variety of threats, including invasive predators, interspecific competition, accidental bycatch, light pollution, and climate change (Dias *et al*. 2019). Seabirds are of high conservation interest, not only because of the large number of threats they face, but also because seabirds are considered ecosystem engineers (i.e. they have a disproportionate impact on their surrounding environment; Orwin *et al*. 2016; Otero *et al*. 2018). As such, seabirds are prime targets for intensive conservation management including translocations and reintroductions (Armstrong & Seddon 2008; Seddon *et al*. 2014). Translocations of seabirds, however, are both labour and cost intensive, especially when highly philopatric species, such as Procellariiformes, are targeted (Miskelly & Taylor 2004; Miskelly *et al*. 2009). Acoustic attraction systems take advantage of the colonial and social nature of many seabirds by broadcasting acoustic cues to attract individuals to localities of conservation interest (Podolsky & Kress 1992; Miskelly & Taylor 2004; Buxton & Jones 2012). The passive nature of these systems renders them cost-efficient and thus acoustic attraction systems have become a common tool to restore and conserve seabird populations (Jones & Kress 2012; Buxton *et al*. 2016; Friesen *et al*. 2017).

The Whenua Hou diving petrel (*Pelecanoides whenuahouensis*; WHDP) is a 'Critically Endangered' seabird species (BirdLife International 2020). The WHDP has recently been split from the South Georgian diving petrel (*P. georgicus*) and here we follow Fischer *et al*. (2018a) in treating the WHDP as a full species. The historic WHDP distribution included numerous colonies throughout southern Aotearoa (New Zealand) and the subantarctic islands (Worthy 1998; Taylor 2000; Wood & Briden 2008; Tennyson 2020). Today, the species is confined to a single remaining breeding colony in a narrow strip of foredunes <20 m from the springtide line on Whenua Hou (Codfish Island; Fig. 1; Fischer *et al*. 2018a, b). The current WHDP population size is estimated at 194–208 adults (Fischer *et al*. 2020). Due to its breeding habits (burrowing in

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fragile foredunes), the WHDP is highly vulnerable to stochastic events, such as storms and storm surges (Cole 2004), and the impending effects of climate change (e.g. increased coastal erosion; Vousdoukas *et al*. 2020). In addition, the WHDP suffers from competition for burrow sites with a congeneric species, the common diving petrel (*P. urinatrix*; CDP; Fischer *et al*. 2017). CDPs breed in low numbers (10–20 pairs) in the same dune system as the WHDP, and probably in higher numbers in other coastal areas throughout Whenua Hou (Taylor 2000; Fischer *et al*. 2017).

To attract WHDPs to burrow sites that are less at risk from storms and storm surges, a custom-made acoustic attraction system in a back dune within the WHDP colony (18 m from the springtide line; Fig. 1) was installed in September 2018. The selected area contained few WHDPs burrows, but still appeared suitable (i.e. limited vegetation cover, low soil penetrability, and steep slopes; Fischer *et al*. 2018b). For the acoustic attraction, calls recorded in previous breeding seasons at six different WHDP burrows, including both solo and duet calls, were used (i.e. calls produced by both sexes were included). WHDP calls were edited together into a "mixtape" which was played on a loop with natural pauses (1 minute between calls, 15 minutes between repetitions of the "mixtape"). CDP and WHDP calls differ markedly and no CDP calls were used in the "mixtape" (Payne & Prince 1979; Fischer *et al*. 2018a). Based on WHDP activity at the breeding colony (Fischer *et al*. 2017), the acoustic attraction system was set to play WHDP calls from 2100 h to 0100 h. To further tempt WHDPs to settle in the vicinity of the acoustic attraction system, ten artificial "starter" burrows (30 cm deep) were installed. To assess the responses of both WHDPs and CDPs, the acoustic attraction system was played for four consecutive nights in each of three time periods during the WHDP courtship phase: 09–12 September 2018, 18–21 September 2018, and 03–06 October 2018. When the acoustic attraction system was operating, the surrounding area was surveyed twice per night, and all WHDPs and CDPs prospecting in its vicinity were caught and banded. Four contour feathers were sampled from flanks of all captured birds (Taylor *et al*. 2010) and used for genetic sex determination (using PCR primers specific to CHD-W gene; Norris-Caneda & Elliott 1998). In addition, two remote cameras and stick palisades at the entrances of the "starter" burrows were used to further monitor WHDP and CDP activity around the acoustic attraction system (Fischer *et al*. 2017). When the acoustic attraction system was not operating, the surrounding area was monitored, both actively and passively (i.e. with remote cameras), for 25 nights during the WHDP courtship period.

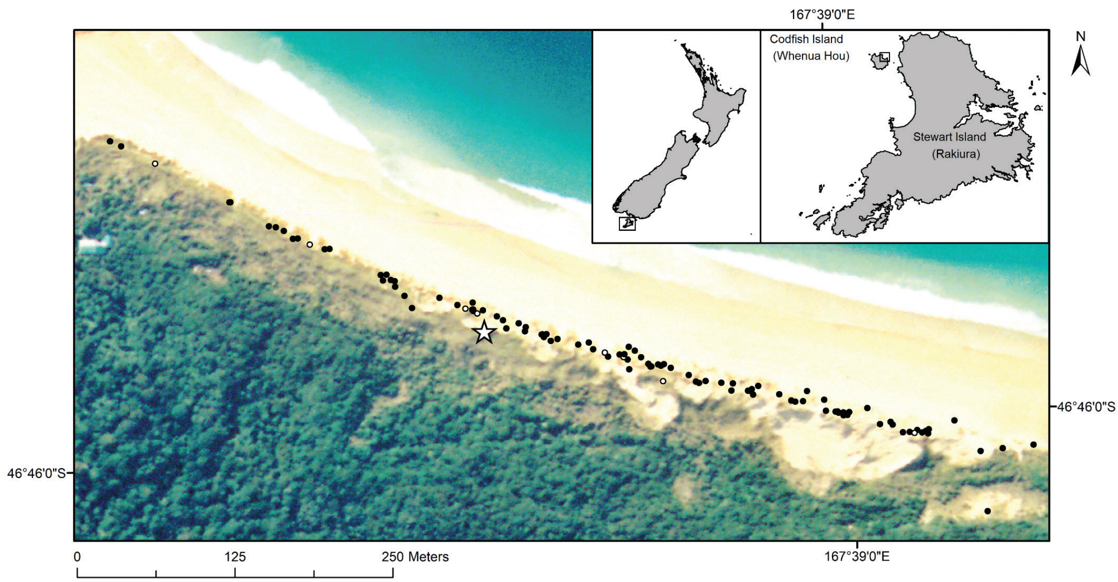

Figure 1. Location of acoustic attraction system (star) in relation to all known Whenua Hou diving petrel (black circles) and common diving petrel burrows (white circles) within the Sealers Bay dunes on Whenua Hou (Codfish Island).

The acoustic attraction system drew in considerably more CDPs than WHDPs. Two WHDPs and 19 CDPs were caught around the acoustic attraction system (Fig. 2). No WHDPs, but multiple CDPs, were recorded on the remote cameras. Of the captured individuals, female CDPs outnumbered male CDPs 9:1 (Table 1). No male WHDPs were caught around the acoustic attraction system. No WHDPs showed any interest in the "starter" burrows. At least two CDPs started digging in these "starter" burrows, but abandoned their efforts after the acoustic attraction system was turned off. When the acoustic attraction system was not broadcasting, no CDPs or WHDPs were detected in the surrounding area.

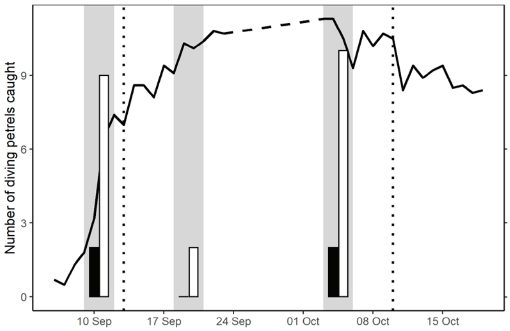

Figure 2. Number of Whenua Hou diving petrels (black bars) and common diving petrels (white bars) caught at the acoustic attraction system, in relation to, 1) the time periods during which the acoustic attraction system was operational (grey), 2) number of active burrows in the colony (based on stick palisades; dashed line = no data) and, 3) Whenua Hou diving petrel phenology (dotted lines; mean arrival date = 13 September, mean lay date = 10 October).

Table 1. Number and sex of diving petrels (WHDP = Whenua Hou diving petrel, CDP = common diving petrel) captured while an acoustic attraction system was operating on Whenua Hou.

Time period	Species	Female	Male
09–12 September	WHDP	2	-
	CDP	7	2
18–21 September	WHDP	-	-
	CDP	2	-
03–06 October	WHDP	2	-
	CDP	9	-
Total	WHDP	2	-
	CDP	17	2

Despite the short operating time of the acoustic attraction system and the absence of CDP calls in the "WHDP mixtape", a comparatively large number of CDPs was attracted. The number of attracted CDPs may suggest that the CDP population on Whenua Hou, in contrast to the WHDP population, is recovering after the eradications of invasive predators (McClelland 2002; Fischer *et al*. 2020). The CDP population may now be expanding from past refugia (i.e. offshore stacks and inaccessible cliffs; Taylor 2000) resulting in a high number of prospecting birds. The disproportionate number of female CDPs attracted to WHDP calls is remarkable. Potentially, prospecting male CDPs dig the burrows and call from these, like other petrels (e.g. grey-faced petrels *Pterodroma gouldi*; Imber 1976). Prospecting female CDPs may search for calling males in flight and then mistake broadcasted WHDP calls for a potential partner. Alternatively, prospecting CDPs may simply be attracted to areas of higher petrel activity, potentially to reduce predation risk (Warham 1996). Some records of non-target species being attracted to social attraction system exist (e.g. fork-tailed storm petrels *Oceanodroma furcata* being attracted to Leach's storm petrel *O. leucorhoa* calls, and vice versa; Buxton & Jones 2012). However, to our knowledge, this constitutes the first record of a non-target species outnumbering a target species at an acoustic attraction site (Podolsky & Kress 1992; Miskelly & Taylor 2004; Sawyer & Fogle 2010; Jones & Kress 2012; Buxton *et al*. 2016; Friesen *et al*. 2017).

A wide range of seabird species have benefited from acoustic attraction systems (Podolsky & Kress 1992; Miskelly & Taylor 2004; Sawyer & Fogle 2010; Jones & Kress 2012; Friesen *et al*. 2017), but this tool may be less useful for the conservation of the WHDP. Any additional CDPs in the WHDP colony are undesirable because this species already competes with the WHDP for burrow sites (Fischer *et al*. 2017). Subsequently, no further attempts were made to attract WHDPs into the less erosion prone back dune. The attraction of CDPs to WHDP calls will create further challenges for future WHDP conservation. As the WHDP is under ongoing pressure from severe weather events (Cole 2004; Fischer *et al*. 2018b), translocation(s) may be a suitable conservation strategy. However, translocation efforts often also utilise acoustic attraction systems to maximise success (Miskelly & Taylor 2004; Miskelly *et al*. 2009). Given the abundance and wide distribution of CDPs in southern Aotearoa (Taylor 2000) and their comparatively high ability to disperse (Miskelly *et al*. 2004), prospecting CDPs may also be drawn to WHDP translocation sites if an acoustic attraction system is operating. Consequently, it may be of high conservation interest to identify the vocal cues in the WHDP repertoire that are less attractive to CDPs, but still attractive to WHDPs (Friesen *et al*. 2017). Otherwise, future WHDP translocations may need to proceed without the aid of acoustic attraction systems, potentially lowering translocation success.

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