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A review of records and research actions for the poorly known Vanuatu Petrel *Pterodroma [cervicalis] occulta*

Peter M. Vaughan[1], Jeremy P. Bird[2], Vincent Bretagnolle[3], Hadoram Shirihai[4], Alan J. D. Tennyson[5], Colin M. Miskelly[5] and Rohan H. Clarke[1]

[1]School of Biological Sciences, Monash University; [2]Institute for Marine and Antarctic Studies; [3]French National Centre for Scientific Research; [4]The Tubenoses Project and [5]Museum of New Zealand, Te Papa Tongarewa

Review Article

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Corresponding author:
Peter M. Vaughan;
Email: peter.vaughan@monash.edu

Summary

Gadfly petrels *Pterodroma* spp. are among the most threatened bird taxa. Conservation interventions have been successfully developed and applied for some gadfly petrel species, but a substantial gap remains in conservation science for this group in the tropical Pacific Ocean. The Vanuatu Petrel *Pterodroma [cervicalis] occulta* is an ideal exemplar to develop a pipeline for conservation science in tropical Pacific gadfly petrels as it is subject to many of the challenges facing other gadfly petrel taxa in the region. We review over 40 pelagic Vanuatu Petrel records and five research expeditions to the only known colony on the island of Vanua Lava, Vanuatu. These records provide a baseline from which to recommend conservation research actions for the taxon. The population status, taxonomy, distribution, and threat profile of the taxon are all poorly known, and these areas are high priorities for future research.

Introduction

Gadfly petrels (*Pterodroma* spp.) are one of the most threatened bird groups in the world (Croxall et al. 2012; Rodriguez et al. 2019). Several species have become extinct in recent history (e.g. Steadman 1989; Tennyson et al. 2015), and others have fallen to critically low numbers since research interest in seabirds began (Simons et al. 2013). Management programmes have been successfully implemented for some of these species, with examples including Bermuda Petrel *Pterodroma cahow*, Zino's Petrel *P. madeira*, and Hawaiian Petrel *P. sandwichensis* (Madeiros et al. 2012; Carlile et al. 2003). While few similarly large-scale management programmes have been implanted in the South Pacific, species such as Chatham Petrel *P. axillaris* and Gould's Petrel *P. leucoptera* have been the focus of successful management in the region (Carlile et al. 2003; Gummer et al. 2015). Conservation successes such as these rely heavily on knowledge of status, threats, ecology, and consequent leverage points for interventions to guide appropriate actions. There remains a suite of South Pacific gadfly petrels that lack fundamental ecological information to inform appropriate conservation responses. This group includes the Collared Petrel *P. brevipes* in Fiji and Vanuatu, and Masatierra Petrel *P. defilippiana* on the Desventuradas and Juan Fernandez Islands (Chile), where fundamental information for conservation management remains unknown.

The recent discovery of a breeding site for the little-known Vanuatu Petrel *P. [cervicalis] occulta* provides a transferable case study for how research and conservation may be conducted for other at-risk species (Totterman 2009). The Vanuatu Petrel is a pale, medium-sized gadfly petrel that breeds on the Banks Islands of northern Vanuatu. It is visually near-indistinguishable from the closely related White-necked Petrel *P. cervicalis*, of which it is considered a subspecies by some authorities (e.g. BirdLife International 2023). Vanuatu Petrel specimens were first collected during the Whitney South Sea Expedition in 1927, but the species was only described in 2001 (Imber and Tennyson 2001). There are very few pelagic records of Vanuatu Petrel, with their identity largely being inferred by proximity to the location of the only known breeding colony on Vanua Lava (Totterman 2009; Shirihai and Bretagnolle 2010). The distribution of the Vanuatu Petrel in areas distant from the breeding grounds is therefore unknown, save for a dead specimen recovered in New South Wales, Australia, in 1983 (Boles et al. 1985), and recent pelagic observations from Ogasawara, Japan, in 2018 and 2020 (Tanoi 2021) and Kiritimati, Kiribati, in 2022 (Flood and Zufelt 2023). These records suggest that Vanuatu and White-necked Petrels likely occur in sympatry across parts of the south-west Pacific Ocean. Ashore, few researchers have visited the Vanuatu Petrel colony, resulting in just a handful of publications documenting basic ecology (Totterman 2009, 2012; Tennyson et al. 2012). Reporting from these research

efforts indicates that the Vanuatu Petrel likely has a small population (Totterman 2009; Tennyson et al. 2012). Potential threats to the long-term viability of the taxon have also been described, including predation of nesting adults, young, and eggs by invasive species, and vulnerability to stochastic environmental catastrophes (Tennyson et al. 2012). None of these threats have been investigated in detail to date. Vanuatu Petrel is one of the least-known gadfly petrels worldwide, with much remaining to be discovered about the taxonomic status, biology, ecology, and conservation status.

Here, we review all Vanuatu Petrel records to identify the necessary research actions to inform conservation of the taxon. Implementing this plan would greatly increase our ecological understanding relevant to Vanuatu Petrel conservation management, and help secure this taxon against contemporary threats. It would also provide valuable insight to potential management programmes for other threatened gadfly petrels in the South Pacific (e.g. Priddel et al. 2008; Bird et al. 2014).

Taxonomy of the Vanuatu Petrel

The paucity of information about the Vanuatu Petrel can be attributed, in part, to its conflicted taxonomic status (Mace 2004). The first documented specimens were six individuals collected in Vanuatu on the Whitney South Sea expedition by Rollo Beck in 1927. These were identified as Juan Fernandez Petrel (*P. externa*), which was considered conspecific with White-necked Petrel at the time (Peters 1931). Falla (1976) was the first to identify the Whitney South Sea specimens as a distinct form of White-necked Petrel, differentiating them from other specimens of *P. cervicalis* by their smaller dimensions. In 1983, a road-killed bird was found in northern New South Wales, Australia (Boles et al. 1985). This bird was originally identified as a White-necked Petrel, but measurements were found to be within the range of the Whitney South Sea specimens (Boles et al. 1985; Imber and Tennyson 2001). From these seven specimens, the Vanuatu Petrel *P. occulta* was described as a distinct species (Imber and Tennyson 2001), based on the ~10% size discrepancy between this taxon and *P. cervicalis*, and putative distinguishing plumage characteristics (*P. occulta* averaging a darker underwing tip).

The taxonomy of the Vanuatu Petrel has remained unsettled, with various authors treating it as a species or subspecies, but no comprehensive review has followed Imber and Tennyson (2001). While Onley and Scofield (2007), Harrison (2020), Schulenberg *et al.* (2021), and Gill et al. (2022) have treated the Vanuatu Petrel as a distinct species, Brooke (2004) and BirdLife International (2023) treat the taxon as *P. cervicalis occulta.* Consequently, the conservation status of Vanuatu Petrel as a distinct species has not been assessed against the International Union for Conservation of Nature and Natural Resources (IUCN) Red List categories and criteria (IUCN 2022).

Recent research on the identification of Vanuatu Petrel at sea has indicated that it is identifiable in some circumstances using a combination of size and plumage (Shirihai and Bretagnolle 2010). However, this work and other publications (e.g. Flood et al. 2017) have demonstrated that some criteria (especially plumage traits) used to support the species status of Vanuatu Petrel (see Imber and Tennyson 2001; Shirihai and Bretagnolle 2010) are subject to overlap with White-necked Petrel, with only a full complement of Vanuatu Petrel-like features (dark underwing point, dark ulna bar, and dark carpal bar) being diagnostic for the taxon. This variation may have contributed to the inconsistent recognition of specific status for *P. occulta.* Some authors have consequently taken a precautionary taxonomic approach, acknowledging the uncertainty of the taxon without assigning a specific or subspecific status to the Vanuatu Petrel (e.g. Howell and Zufelt 2019). A more comprehensive assessment of breeding phenology, comparative vocalisations, and genetics is needed to resolve this ongoing uncertainty.

Records of Vanuatu Petrel

Terrestrial records

Qetlap is the local name for the Vanuatu Petrel on Vanua Lava and neighbouring islands (HS 2020, personal observation). The breeding colony was known to local people prior to the publication of its location (Totterman 2009). The first written record of the colony is contained in the notes of John Ralph Bisiwei, documenting large chicks in burrows around Qwelraqraq in July 1997 (HS 2020, personal observation). It is unclear whether knowledge of the species on neighbouring islands arises solely from visits to Vanua Lava, or also historical breeding activity on Mota Lava. Relatively little is understood about the extent of local knowledge of the Vanuatu Petrel and its ecology (Totterman 2009; HS 2020, personal observation). This may mask a substantial knowledge base of information about the historical range and contemporary behaviour of the species.

In 1983, a single Vanuatu Petrel was found dead near Kempsey, New South Wales, on the eastern seaboard of Australia (Boles et al. 1985). This record is a case of terrestrial vagrancy (an unusual event of a pelagic seabird being found well inland), and not indicative of the breeding distribution of the Vanuatu Petrel. Given this terrestrial record necessarily arose from a bird present in coastal Australian waters, it is considered in more detail under distribution.

The first formal documentation of Vanuatu Petrel ashore on Vanua Lava arose from a visit from 18 to 25 February 2009 (Totterman 2009). This followed an inconclusive search of the same area on the night of 2 February 2007 (Totterman 2009). Surveys here incorporated nocturnal call surveys and diurnal burrow searches. Burrows were found at Qwelraqraq ~590 m a.s.l. on the slopes of Mount Suretamatai in the centre of Vanua Lava (-13.82, 167.46) (Totterman 2009). Eleven putative burrows were documented across three subcolonies, some containing incubating birds (Totterman 2009).

Shirihai and Bretagnolle (2010) reported observations of Vanuatu Petrel at sea immediately adjacent to Vanua Lava (see subsequent section), with VB visiting the Qwelraqraq colony in December 2009. VB collected acoustic data of displaying birds, and roughly mapped the colony of the southern slope of Mount Suretamatai.

In 2011, AJDT, CMM, and Totterman (2012) undertook research at the Qwelraqraq colony from 5 to 28 March. This is the most comprehensively documented terrestrial research effort concerning Vanuatu Petrel, with 16 burrows containing eggs found, 27 individual birds sampled for genetic and morphological data, and the boundaries of the known colony extended (Miskelly 2011a; Miskelly 2011b). Details of the breeding cycle were collected, with reproduction occurring approximately six weeks later than White-necked Petrel, between February and July (Tennyson et al. 2012).

VB and HS visited the Qwelraqraq colony from 22 to 29 April 2011, with a focus on studying the Magnificent Petrel *P. brevipes magnificens*, a local taxon of Collared Petrel *P. brevipes* (Bretagnolle and Shirihai 2010; Shirihai and Bretagnolle 2011). Thirteen Vanuatu Petrels were sampled for genetic and morphometric data, and additional vocalisation data and playback tests were collected on this expedition (unpublished data). Hatching success was checked

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Table 1. Summary of research effort concerning Vanuatu Petrel *Pterodroma [cervicalis] occulta* on Vanua Lava, Vanuatu

Year	Date(s)	Count at colony	Information collected	Researchers
2007	2 February	Not available	Not available	Totterman
2009	18–25 February	11 burrows	Morphometric Phenotypic	Totterman
2009	December	3 birds sampled	Genetic Morphometric Acoustic	Bretagnolle
2011	5–28 March	27 birds sampled 16 burrows	Population Genetic Acoustic	Tennyson, Miskelly and Totterman
2011	22–29 April	13 birds sampled 2,500 pairs estimated	Genetic Morphometric Acoustic Population	Bretagnolle and Shirihai

for burrows tagged by the team who visited the colony in March. Between their 2009 and 2011 expeditions, a rough population estimate of a minimum 2,500 pairs was also generated based on VB's experience of calling activity in *Pterodroma* spp. colonies (unpublished data).

HS visited Vanua Lava in 2020, but did not reach the breeding colony. A summary of the expeditions that have visited the Vanuatu Petrel colony to date is contained in Table 1.

At-sea records

We compiled 43 pelagic records identified as Vanuatu Petrel documented between 1927 and 2023. These were collated from primary literature (Shirihai et al. 2009; Shirihai and Bretagnolle 2010; Flood et al. 2017; Flood and Zufelt 2023), accounts of researchers (Harrison 2010; Shirihai and Bretagnolle 2011, unpublished data; Tanoi 2021; van der Wielen and van der Vliet 2017), and other online records from recreational birdwatchers (eBird 2023a). Records were assessed according to the criteria in Bird et al. (2014), with 37 out of 43 records meeting confirmed or high reliability thresholds. All records, bar the 1927 collection of the type specimens and the Australian specimen recovery, have occurred since 2006. All but three pelagic observations of Vanuatu Petrels have been claimed from ~150 km north, and ~500–650 km east, west, and south of Vanua Lava, in addition to the dead bird recovered near Kempsey, which reflects the presence of a Vanuatu Petrel in east coast Australian waters (Figure 1B). Numbers of birds have ranged from lone individuals up to an aggregation of 262 in April 2011 (HS and VB unpublished data), with eight aggregations containing ≥20 birds. Flocking behaviour seems to be most common in close proximity to Vanua Lava (Shirihai and Bretagnolle 2010), where, similarly to other petrel species (e.g. Marchant and Higgins 1990; Rayner et al. 2020), Vanuatu Petrels congregate late in the day before moving inland to the breeding colony at night. Away from the Banks Islands, Tanoi (2021) reported Vanuatu Petrels from at-sea observations off Ogasawara Island in 2018 and 2020 (both 25°58′N, 141°82′E), and Flood and Zufelt (2023) identified a single Vanuatu Petrel ~1,500 km north of Kiritimati, Kiribati (Figure 1B).

Distribution of the Vanuatu Petrel

The contemporary, putative distribution of the Vanuatu Petrel is centred on the one known breeding colony on Vanua Lava (Figure 1). Given the extreme difficulty of reliably separating Vanuatu Petrels from White-necked Petrels at sea (Shirihai and Bretagnolle 2010), most at-sea records are inferred by proximity to this site, likely underrepresenting the true distribution of the taxon (Figure 1). Recent tracking of provisioning trips by breeding White-necked Petrels from Phillip Island (-29.12, 167.95; one of two current breeding sites for this species) recorded mean "short" trips of 234 km (range Phillip Island 25–433) and 206 km (30–480) and mean "long" trips of 1,063 km (546–2,680) and 810 km (520–1,451) (Halpin et al. 2022). It is possible that the Vanuatu Petrel is similar. While observational surveys are the most complete way of understanding the at-sea distribution of seabirds, in the case of rare species that are difficult to identify tracking studies provide more reliable and complete information on pelagic distribution. No Vanuatu Petrels have been tracked to date. Further, no analysis has been published of White-necked Petrel movement in the non-breeding season, though a circum-Pacific distribution has been tracked (Seabird Tracking Database 2023). White-necked/Vanuatu Petrels have been recorded across a broad distribution in the non-breeding season, ranging from Macauley Island (Kermadec Islands, New Zealand), the largest breeding colony, north in the Pacific Ocean to Japan, east to Hawaii and continental USA, and west into continental Australian waters (Howell and Zufelt 2019; Menkhorst et al. 2019) (Figure 1B).

Many petrel populations in the Pacific have been extirpated by invasive species. It is likely that historically Vanuatu Petrels were more widespread. Paleontological records could shed some light on their historical terrestrial distribution, but procellariiform seabird fossils are known from relatively few sites in Melanesia (Worthy and Anderson 2009). Bones of a single putative Juan Fernandez Petrel/White-necked Petrel have been collected from Viti Levu, Fiji, from a Peregrine Falcon *Falco peregrinus* pellet deposit (Worthy and Anderson 2009) (Figure 1A). Whilst these bones may pertain to Vanuatu Petrel, whether this individual was taken as prey at sea (e.g. Jiguet et al. 2007) or at a breeding colony is unknown, therefore it is uncertain whether this record indicates local breeding activity.

There have been searches outside Vanua Lava for Vanuatu Petrel breeding colonies, though all have been unsuccessful. Totterman (2009) conducted a search of Mere Lava (near where the Whitney South Sea Expedition specimens were collected) in 2005. VB and HS did not find any evidence of breeding on Mota Lava (11.6 km east of Vanua Lava) and Ureparapara (20.6 km north-west of Vanua Lava) during their research efforts. Gaua Island (27.6 km south of Vanua Lava) remains a potential breeding area.

Threats

Invasive/feral predators are the primary cause of declines in breeding Procellariiformes while ashore (Rodriguez et al. 2019). Cats (*Felis catus*), dogs (*Canis familiaris*), Black and Pacific Rats (*Rattus rattus and R. exulans*), and pigs (*Sus scrofa*) have all been reported on Vanua Lava (Tennyson et al. 2012). These species are all predators of burrow/ground-nesting seabirds elsewhere (Spatz et al. 2014). Furthermore, Tennyson et al. (2012) reported finding cat-killed remains of adult Vanuatu Petrels, and detected evidence of rat predation of eggs. When cats are removed seabird populations can show signs of recovery, even while rodents are still present (e.g. Macquarie Island; Robinson and Copson 2014, but see Rayner et al. 2007a, 2007b). The occurrence of current and historical harvesting for human food is subject to conjecture, with published reports that the practice ceased in the 1940s (Totterman 2009), but

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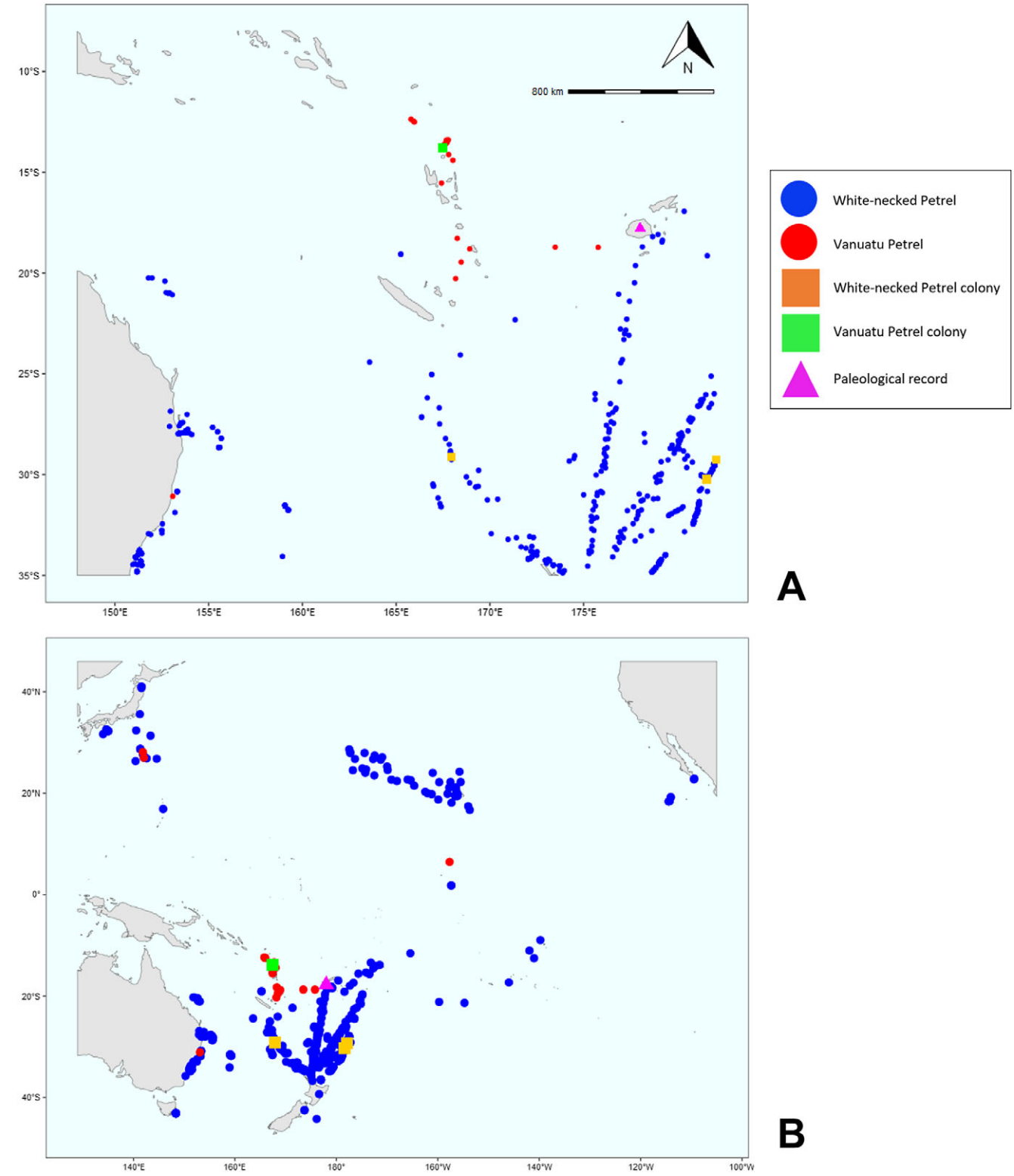

Figure 1. Relative distribution and spatial bias of Vanuatu Petrel *Pterodroma [cervicalis] occulta* records and White-necked Petrel *P. cervicalis* sightings including at-sea observations, breeding grounds, and paleontological records in (A) the south-west Pacific Ocean and (B) the Pacific Ocean. White-necked Petrel observations were downloaded from eBird (2023b).

recent communications with local authorities suggest it may be ongoing (Vanuatu Department of Environmental Protection and Conservation 2023, personal communication). Other human interaction through tourism or unregulated research poses a threat to the colony, with traffic through the site to observe geology or the birds likely to have negative consequences for predation risk by opening tracks (Ainley et al. 2001). Potential interactions with humans and other species further introduce the possibility of disease in Vanuatu Petrels. Avian malaria has been documented in several passerine species on Vanua Lava (Clark 2015). This

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disease has contributed to seabird population declines in Hawaii (Harrison 1990), and has been documented in seabird species elsewhere (e.g. Vanstreels et al. 2020). In tandem with these ongoing/potential pressures, the small population and restricted colony size of the Vanuatu Petrel likely make it vulnerable to environmental catastrophes. Vanuatu lies within an area of high cyclone activity (Magee et al. 2016), and severe storms may pose some risk to breeding birds and their burrows (Hass et al. 2012). The colony is also located on the slopes of an active volcano, which places it at some risk from future eruptions (Tennyson et al. 2012).

At sea, it is likely that Vanuatu Petrels face threats common to other gadfly petrels (Rodriguez et al. 2019). Climate change could entail long-term prey stock reductions through prey mortality/range shifts across their distribution. This is a key factor in many seabird breeding colony failures (Ramirez et al. 2018). Gadfly petrels are generally less susceptible to this process than other procellariiform species, as they forage over long distances actively searching for prey, rather than targeting specific areas of known high productivity (Halpin et al. 2022). With an unknown pelagic range, this process may affect Vanuatu Petrels more acutely than other gadfly petrels. Climate change also contributes to the threat of extreme weather events, as these are projected to increase in frequency and intensity with changing ocean dynamics (Hass et al. 2012). Gadfly petrels are generally less susceptible to pelagic threats common to Procellariforms, such as ingesting plastic pollution and fisheries bycatch mortality (Rodriguez et al. 2019). However, behavioural observations of Vanuatu Petrels foraging ahead of bait balls close to the sea surface (Shirihai and Bretagnolle 2010) indicate possible interactions with these threats.

Research actions

The taxonomic uncertainty surrounding Vanuatu Petrel has prevented universal recognition at species level, creating ongoing uncertainty about allocation of attention and resources to its conservation. This, combined with a lack of information on the size, distribution, and trends of the population, has prevented formal assessment of its conservation status. The limited information on threats also inhibits planning and initiating targeted conservation actions. Here, we identify a prioritised set of research activities to fill these knowledge gaps towards developing a comprehensive conservation management plan for the taxon, and suggest appropriate timing for ongoing research.

1. **Population size at known breeding sites.** This is a key factor of extinction risk and therefore an essential part of conservation assessment (Bland et al. 2017). Key consideration should be given to Red List thresholds. With *a priori* estimates suggesting the Vanuatu Petrel is not widespread on Vanua Lava, targeted search surveys informed by local knowledge, spotlighting/auditory surveys, and habitat assessment are likely to be more effective than an unbiased survey design (Bird et al. 2022). In the presence of dense ground cover, call surveys to map the colony and call playback to detect burrows are likely to be the most effective techniques (e.g. Militao et al. 2017). White-necked Petrels on Phillip Island (Australia) are occasionally surface nesters, implying a possibility that Vanuatu Petrels could do the same with suitable ground cover (Halpin et al. 2021a), making searches for all nesting types, rather than only burrows, important.
2. **Terrestrial distribution beyond known breeding site.** This is fundamental to identifying threats to which a taxon is exposed and the spatial and temporal scales over which threats act. Initial distribution mapping would focus on discovering new breeding areas on Vanua Lava, combining targeted searches of likely breeding areas and unbiased approaches (e.g. Rayner et al. 2007a; O'Brien et al. 2016). This would maximise the likelihood of discovering new breeding areas while accounting for potentially unknown breeding habitat requirements for Vanuatu Petrel. Remote sensing technologies should be explored for conducting habitat searches to maximise efficiency of researcher effort. Predictive modelling could then be applied to discover other likely breeding areas, building and projecting habitat suitability models across Vanua Lava, and other islands in the South Pacific (e.g. Bird et al. 2014; Van Zandt et al. 2014). Areas predicted to have high suitability based on modelling should then be searched for breeding activity to identify additional populations. Where novel breeding areas are identified, research should return to the start, and determine population size at those novel sites as a priority.
3. **Population trend.** This is also a key factor of extinction risk and another essential part of conservation assessment (Bland et al. 2017). Given the high uncertainty in most population estimates of burrowing seabirds, and the challenges inherent in island-wide surveys, repeating surveys is an unreliable method for assessing trends (Bird et al. 2021). It would be preferable to establish reliable indices for monitoring population trends that use remote technologies, such as song meters to detect relative calling activity that can be deployed in the long term and visited infrequently (e.g. Buxton et al. 2013).
4. **Threat assessment.** This is a fundamental step towards any management intervention for Vanuatu Petrel that must be informed by the baseline parameters above. Standardised surveys would be an effective approach for quantifying terrestrial threats. Remote sensing with trail cameras has substantial advantages for detecting invasive fauna as a likely key threatening process (O'Connell et al. 2011), and should be a priority. Community consultation will be required to understand the current status of harvesting petrels for food.
5. **Community engagement.** Local knowledge is essential to conduct Vanuatu Petrel conservation research and greatly improve long-term prospects of conservation success. Local governance of the site of the Vanuatu Petrel colony is the most important pathway to limiting human activity, including tourism, in the breeding area, mitigating this potential threat. Establishing local champions trained in appropriate methods for continuing research, coupled with broader community involvement, will be an essential component to any conservation programme (e.g. Kereseka 2014).
6. **Pelagic distribution.** This information is required for understanding threats to Vanuatu Petrel away from their breeding area/s. Deploying biologgers on individuals while ashore is the most representative method for assessing seabird distribution at sea, especially where taxa can be challenging to identify by vessel-based observers. GPS and geolocation-sensing tracking should be employed to generate both high-resolution and long-term tracking of the Vanuatu Petrel year-round (Halpin et al. 2021b). Assessment of pelagic threats would entail associating bird tracks with remotely sensed data through spatially explicit modelling approaches, building species distribution models to predict areas of high bird usage where threats may be acting.

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7. **Taxonomy.** Resolving the status of Vanuatu Petrel would improve prospects for appropriate conservation activity (e.g. Robertson et al. 2011). A comprehensive assessment including morphology, phenotype, vocalisations, phenology, other behaviour, and genetics to compare the taxon with the White-necked Petrel, and elucidate its taxonomic affinities with other *Pterodroma* petrels, is desirable (e.g. Wood et al. 2017).

The proposed priority for these activities is centred around rapidly and efficiently generating knowledge for effective conservation of the known breeding site of the Vanuatu Petrel, while providing information to inform targeted searches for new breeding areas. Substantial gains towards all these research priorities can be realised with a series of focused research expeditions to Vanua Lava. Repeat survey effort would then greatly increase the quantity and usefulness of much of this prioritised information. Integrating local communities in such research, and identifying and enabling local champions for ongoing conservation efforts to facilitate future research would circumvent many of the logistical challenges associated with Melanesian petrel research and improve the likelihood of rigorous future monitoring (Kereseka 2014; Dawson et al. 2021). A full threat assessment and subsequent conservation management plan for the Vanuatu Petrel would be a useful outcome from the research we propose here. With sufficient information, the focus of work should shift to developing and implementing management interventions for all significant threats to the Vanuatu Petrel. Threat mitigation for the Vanuatu Petrel would have flow-on benefits for other burrow-nesting seabirds breeding on Vanua Lava. Magnificent Petrels (and Polynesian Storm-petrel *Nesofregetta fuliginosa*) breed in proximity to Vanuatu Petrels (Tennyson et al. 2012; VB 2011, personal observation), and are likely subject to some of the same threats (Tennyson et al. 2012; Pierce et al. 2020). Such a well-designed and implemented conservation management strategy would secure the survival of Vanuatu Petrel, and provide a useful pipeline for research and management of other poorly known Melanesian petrels subject to similar threats (e.g. Priddel et al. 2008; Bird et al. 2014).

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