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Pelagic birds around Rapa and Marotiri, French Polynesia, October–December 2019, with notes on Rapa Shearwater *Puffinus myrtae* and Titan Storm Petrel *Fregetta [grallaria] titan*

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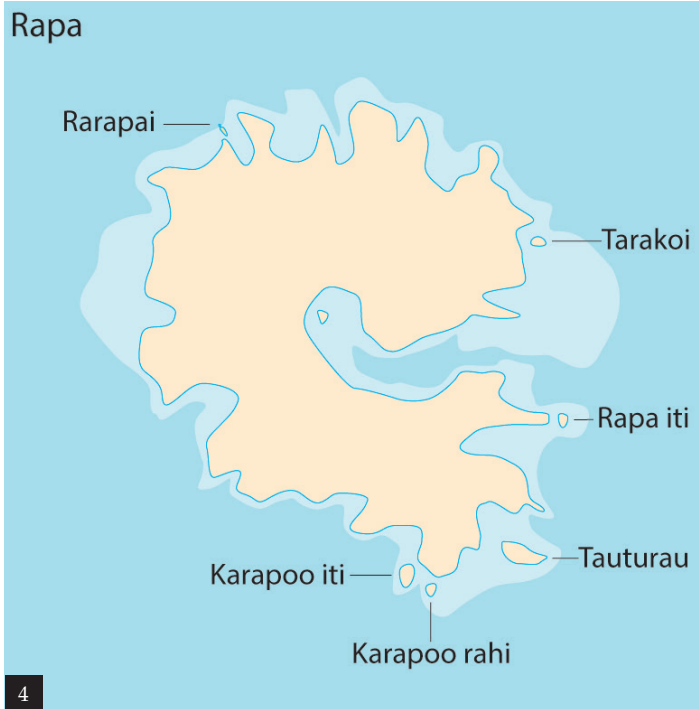
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SUMMARY.—We report pelagic observations from around Rapa Island and Marotiri Rocks, in the Austral Islands, French Polynesia, made during the first dedicated at-sea survey of birds in the region, during October–December 2019. We recommend that the regional occurrence of several seabird species be modified and that the list of avifauna for Rapa and Marotiri, the Austral Islands, and East Polynesia variously be amended to include Juan Fernández Petrel *Pterodroma externa*, Mottled Petrel *P. inexpectata*, Gould’s Petrel *P. leucoptera*, Stejneger’s Petrel *P. longirostris*, Buller’s Shearwater *Ardenna bulleri* and Arctic Skua *Stercorarius parasiticus*. Two Gould’s Petrels were behaving as if breeding, and the timing of egg laying by Christmas Shearwater *Puffinus nativitatis* is apparently somewhat earlier than the species’ other populations. We found Polynesian Storm Petrel *Nesofregetta fuliginosa* foraging in large numbers around Marotiri suggesting a hitherto unrecognised and perhaps significant breeding population; we also found large numbers around Rapa. Titan Storm Petrel foraged off Rapa in substantial numbers and c.5% appeared to be a variant, raising the possibility of two distinctive phenotypes. We include at-sea images and a field description of ‘classic’ Rapa Shearwater *Puffinus myrtae*, and report an unidentified small *Puffinus* seen at Marotiri. Our survey adds significant new information to knowledge of seabirds in this region, and in combination with previous work argues strongly for the conservation of Rapa, Marotiri and the surrounding ocean’s pelagic birds.

Background and Methods

The Austral Islands are the southernmost archipelago in French Polynesia, South Pacific. The old volcanic Rapa Island (27°35’S, 144°20’W; Figs. 1–2) and Marotiri Rocks (27°55’S, 143°26’W; Fig. 3) are the southernmost of the Austral Islands. Immediately adjacent to the 38.5 km² Rapa are nine islets that are important for breeding seabirds, notably Karapoo iti, Karapoo rahi, Rapa iti, Tauturau, Tarakoi, and Rarapai (Fig. 4). Marotiri comprises four main rocks with a combined total of 0.04 km² of land over c.9 km² of ocean. Rapa is home to just over 500 people (2017 census) and Marotiri is uninhabited. Climate is subtropical (i.e., south of 23°50’S) whilst that of most of French Polynesia, including the remainder of the Austral Islands, is tropical. Tropical seabirds from further north rarely reach Rapa or Marotiri (e.g., boobies and frigatebirds; Thibault & Cibois 2017). The region is geographically isolated, and the only scheduled means of travel is via a handful of freight boats per year to Rapa from Tahiti, in the Society Islands, >650 nm to the north. Expedition cruisers rarely venture to this corner of French Polynesia.

The most up-to-date summary of the occurrence of seabirds at Rapa and Marotiri is presented in the biogeographic atlas for East Polynesia by Thibault & Cibois (2017). The



Figures 1–2. Rapa Island, Austral Islands, French Polynesia, December 2019 (Tubenoses Project, © H. Shirihai)

Figure 3. Marotiri Rocks, Austral Islands, French Polynesia, December 2019 (Tubenoses Project, © H. Shirihai)

Figure 4. Map of Rapa Island showing the main islets with seabird colonies.

atlas is our baseline reference. Thibault & Cibois (2017) is a testament to the great paucity of at-sea survey work undertaken in this remote region. Of concern is the limited knowledge concerning two tubenoses endemic to Rapa and Marotiri; Rapa Shearwater *Puffinus myrtae* and Titan Storm Petrel *Fregatta [grallaria] titan*.



Surveys at sea near to breeding islands, especially those difficult to survey, can add valuable insights into the size of a breeding population (e.g., Shirihai *et al.* 2014, 2015b, Flood & Zufelt 2018). They can also help establish the importance of a region of ocean for passage or otherwise non-breeding seabirds (e.g., Ballance 2007, Lewison *et al.* 2012, Poole *et al.* 2014, Serratos *et al.* 2020). Combined results of surveys of breeding populations and passage seabirds help to identify regions with high-priority credentials for international conservation.

We undertook at-sea survey work in the waters around Rapa and Marotiri during October–December 2019. The October survey was yacht-based, whilst the November–December work was land-based. The former survey led by RLF & KZ was carried out on 24–27 October, and involved a team of six ornithologists on the 18-m yacht *Sauvage*. The survey formed part of a longer at-sea expedition, 15 October–11 November, from the Gambier Islands to Tahiti (Flood & Zufelt 2021). The survey off Rapa was shorter than planned due to a tropical storm approaching from the Cook Islands. The land-based survey by HS employed five different fishing motorboats of sizes (max. 9 m in length) suitable for the distances travelled and the sea conditions at the time. Additional land-based research focused on seabird colonies (Shirihai 2020a). HS's lengthy trip to Rapa formed part of the ongoing Tubenoses Project (Shirihai & Bretagnolle in prep.), and a continuation of his study into *Puffinus myrtae* (Shirihai *et al.* 2017) and of the *Fregetta grallaria* complex with a focus on *F. [g.] titan*. HS also explored the impact of feral cats on petrels breeding on Rapa. His studies in the Austral Islands were in collaboration with the Société d'Ornithologie de Polynésie that operates long-term conservation projects across French Polynesia, involving monitoring and conservation management including rat and feral goat extirpation.

Our at-sea surveys mainly concentrated on seamounts and areas considered likely to observe dawn departure and dusk return by Rapa Shearwaters from their known breeding islets east and south of Rapa (Holyoak & Thibault 1984, Thibault & Varney 1991, Thibault & Cibois 2017). The date, time, location, and weather conditions during each day of survey are summarised in Table 1. The yacht-based survey typically chummed for 2–6 hours at two locations per day, and moved between locations in the midday hours. Additionally, surveys were made while sailing away from Marotiri and Rapa. The land-based survey motored to a designated location and chummed for 3–9 hours, depending on circumstances. To attract seabirds, all surveys used fish oil occasionally supplemented by fish offal.

Counts were standardised for effort. For each chumming session, we made an approximate conservative estimate of the total number of individuals of each species seen (A). Each chumming session was divided into three equal periods (X, Y, Z) and 'A' was estimated from the max. number of birds in view simultaneously in each period (A: X, Y, Z). When the count was small only the total number was recorded (A). The counts were comparable because they were hour-based and employed the same chumming technique.

A summary of the results and a discussion are presented below. Supplementary information online incorporates detailed results for tubenoses (a complete set of counts) with notes on their behaviour and identification.

Results

WHITE-FACED STORM PETREL *Pelagodroma marina*

At Seamount 1; two on 12 November, three on 18 November, and one on 29 November.

WHITE-BELLIED STORM PETREL *Fregetta grallaria*

Regularly encountered throughout the survey, with several / many tens per day off Marotiri and in all directions off Rapa, typically in mixed-species flocks with Polynesian Storm



Figure 5. Two Polynesian Storm Petrels *Nesofregatta fuliginosa* (top and centre left) and three 'classic' Titan Storm Petrels *Fregatta [grallaria] titan*, Rapa Island, Austral Islands, French Polynesia, November 2019, showing the exceptionally large size of *titan* relative to other *Fregatta*, and approaching that of the particularly large Rapa form of *N. fuliginosa* (Tubenoses Project, © H. Shirihai)

Petrels *Nesofregatta fuliginosa* (Fig. 5). On 24 October, two were seen when approaching Marotiri from the north-east, two were attracted to chum in calm conditions in five hours close to Marotiri and, on departure towards Rapa, four were attracted to the yacht's stern using a fish oil drip. However, *c.*60 came to chum there on 24 November. Off Rapa observed throughout the survey period, with max. daily counts in each month involving *c.*90 on 25 October, 120 on 12 November, and >100 on 3 December.

POLYNESIAN STORM PETREL *Nesofregatta fuliginosa*

Regularly encountered throughout our survey, with several / many tens per day off Marotiri and in all directions off Rapa. At Marotiri, at least 80 on 24 October and at least 60 on 24 November. On 26 October, surveys 10 nm east of Rapa and at Seamount 2 produced 60 and 40, respectively. The two highest counts in November were 240 on 12 November (at Seamount 1) and 30 on 20 November (17 nm south of Rapa). Thereafter, in November and December, numbers off Rapa decreased notably, with just 2–10 birds per day.

BULLER'S ALBATROSS *Thalassarche [bulleri] bulleri / platei*

Two adults on 24 October near Marotiri, at 27°87'25"S, 143°48'86"W and 27°91'83"S, 143°32'45"W, respectively (distinguished by differences in plumage).

MURPHY'S PETREL *Pterodroma ultima*

Approximately five and six off Marotiri on 24 October and 24 November, respectively. During October–December, observed in all directions around Rapa with up to ten per chumming session.

JUAN FERNÁNDEZ PETREL *Pterodroma externa*

None recorded in October, but regular in small numbers in November–December, with the majority recorded at Seamount 1. Max. daily count 20 birds, with 15 on two other days, otherwise up to seven per day, with a conservative estimate of 50 or more in the period.

TABLE 1

Survey effort: date, time, location, weather conditions (max. wind speed in brackets) and observers.

Locations: off Marotiri Rocks 1 (27°90'61"S, 143°49'27"W), off Marotiri Rocks 2 (27°52'46.62"S, 143°29'31.41"W), Seamount 1 (21 nm north-east of Rapa Island, 27°25'38.38"S, 144°0'58.51"W, known locally as 'Papako'), Seamount 2 (10 nm south-east of Rapa, 27°44'57.91"S, 144°7'7.76"W). Prevailing wind was from the south-east and its strength varied from calm (Beaufort 0) to a strong breeze (Beaufort 6).

Date	Time (h)	Location	Weather conditions	Observers
24 Oct	04.30–09.00	Sail south-west to Marotiri	SE 5 (10) knots, cloudy	RLF, KZ <i>et al.</i>
	11.00–16.00	Off Marotiri 1		
	16.00–18.00	Sail north-west to Rapa		
25 Oct	04.30–06.30	15 nm east of Rapa	SE 5–10 (15) knots, partially cloudy	RLF, KZ <i>et al.</i>
	12.00–18.00	Seamount 2		
26 Oct	04.30–12.00	10 nm east of Rapa	SE 15–20 (30) knots, cloudy	RLF, KZ <i>et al.</i>
	14.00–18.00	Seamount 2		
27 Oct	04.30–11.00	Seamount 2	SE 10–15 (20) knots, partially cloudy	RLF, KZ <i>et al.</i>
	14.00–18.00	Sail north-west from Rapa		
12 Nov	04.30–12.00	Seamount 1	SE 11–15 (24) knots, partially cloudy	HS
13 Nov	14.30–18.00	2–5 nm east-southeast of Rapa	SE 12 (18) knots, partially cloudy	HS
16 Nov	15.00–18.00	Seamount 2	E 11 (20) knots, partly cloudy	HS
18 Nov	05.30–14.00	Seamount 1	E 16 (22) knots, cloudy with occasional rain	HS
20 Nov	13.00–18.00	17 nm south of Rapa	SE 15 (25) knots, partially cloudy	HS
24 Nov	05.00–10.00	Off Marotiri 2	ESE 10–17 (28) knots, sunny to partly cloudy	HS
26 Nov	05.30–14.00	10 nm west-northwest of Rapa	N 16 (25) knots, cloudy with occasional rain	HS
29 Nov	05.30–14.00	Seamount 1	E 12 (23) knots, cloudy	HS
1 Dec	06.30–12.30	Seamount 2	SE 15 (24) knots, partially cloudy	HS
3 Dec	06.30–12.30	Seamount 1	SE 16 (23) knots, partially cloudy	HS
4 Dec	06.30–14.30	10 nm north-northeast of Rapa	SE 12 (18) knots, cloudy	HS
8 Dec	06.00–08.30	Seamount 2	SE 15–20 (25–32) knots, cloudy	HS
13 Dec	05.30–10.30	10 nm north-northeast of Rapa	SE 20 (30) knots, cloudy with frequent rain	HS
14 Dec	10.30–17.00	Seamount 1	SE 15–22 (33) knots, sunny then cloudy with rain	HS

KERMADEC PETREL *Pterodroma neglecta*

Surveys off Rapa found up to 20 per chumming session, usually *c.*10, and tens were seen flying in and out of colonies. None was seen at Marotiri on 24 October, on a day with little wind, but on 24 November *c.*15 were observed.

MOTTLED PETREL *Pterodroma inexpectata*

One at Seamount 1 on 12 November and one 10 nm west-northwest of Rapa on 26 November.

BLACK-WINGED PETREL *Pterodroma nigripennis*

None in October. Present from the start of the land-based survey on 12 November, with 6–35 per count, usually double figures, with the largest numbers mainly at Seamount 1. In November–December, tens were observed flying in and out of colonies, where the species was constantly in view.

GOULD'S PETREL *Pterodroma leucoptera*

Observed in November–December off Rapa, but not Marotiri, on eight of 14 survey days, in small numbers (1–6 birds).

STEJNEGER'S PETREL *Pterodroma longirostris*

Our surveys found small numbers, concentrated in November, involving up to five per day, with one on 26 October and two on 3 December.

TAHITI PETREL *Pseudobulweria rostrata*

One on 27 October off Rapa at Seamount 2.

GREY PETREL *Procellaria cinerea*

Found off Rapa on four out of five visits to Seamount 1 in November–December, with notable counts of ten and 15 per day in November, otherwise singles. One at Seamount 2 on 16 November. Surveys at Marotiri in October and November found none.

BLACK PETREL *Procellaria parkinsoni*

Fairly regularly observed in all directions off Rapa in October–November, with 1–8 per day. Not recorded in December (the breeding season). Surveys off Marotiri in October–November found none.

WEDGE-TAILED SHEARWATER *Ardenna pacifica*

Off Marotiri, three on 24 October, but c.80 there on 24 November (the largest count of the survey). Regular in all directions off Rapa, where seven counts of 13–30 per day. All those recorded were dark morph.

BULLER'S SHEARWATER *Ardenna bulleri*

None off Rapa or Marotiri in October, and none off Marotiri in November. Encountered roughly every other trip off Rapa in November and December with 1–5 per day.

SOOTY SHEARWATER *Ardenna grisea*

None in October. Regular off Rapa and Marotiri in November–December with 1–6 per day.

CHRISTMAS SHEARWATER *Ardenna nativitatis*

Regularly observed, with several / many tens off Marotiri and in all directions off Rapa. Forty at Marotiri on 24 October, at the start of the breeding season, with 300 on 24 November, when breeding is well underway, suggesting a notable nesting population on the Rocks. Surveys off Rapa in October found 20–30 per day, and counts steadily increased from 30 on 27 October to 150 on 3 December, with 50–70 per day thereafter. In November–December, tens were observed flying in and out of colonies during the day.

RAPA SHEARWATER *Puffinus myrtae*

Ten between 25 October and 26 November. In October, seven were seen heading away from the island between 04.45 and 05.30 h, all but one east and south-east of Rapa, and one was seen heading towards the island at 17.45 h, east of Rapa. In November, a juvenile was seen at c.15.00 h near Seamount 2, and one was seen midway between Marotiri and Rapa during the day.

SHEARWATER SP. *Puffinus sp.*

At Marotiri, HS observed a small 'bicoloured' *Puffinus* on the evening of 23 November. Its plumage did not match 'classic' Rapa Shearwater, having less white on the underwing and on the head-sides. It circled the breeding cliffs from 17.00 h until dark among many Christmas Shearwaters. Diurnal activity has not been recorded in Rapa Shearwater, which

apparently does not breed on Marotiri, and November lies outside that species' known breeding season. Circumstances did not permit photography.

Other seabirds

Brown Noddy *Anous stolidus*.—Many hundreds of the nominate subspecies at Marotiri on 24 October and 24 November. Observations while travelling to chumming locations off Rapa, in October–December, involved tens of birds, although hundreds were noted at feeding frenzies.

Grey Noddy *Anous ceruleus*.—Numbers of *A. [c.] albivitta* roughly the same as Brown Noddy.

White Noddy *Gygis alba*.—At Marotiri, tens of *G. [a.] candida* on 24 October and 24 November. While travelling to chumming locations off Rapa, in October–December, tens were seen, although 50–100 occurred at feeding frenzies. The least common of the noddies during our survey.

Sooty Tern *Onychoprion fuscatus*.—Two during each of the two surveys at Marotiri on 24 October and 24 November. At Seamount 1, three on 12 November, two on 18 November, and four on 29 November.

Red-tailed Tropicbird *Phaethon rubricauda*.—At Marotiri, *c.*40–50 were logged on 24 October and *c.*20 on 24 November. Most birds at Rapa were seen at suitable breeding cliffs where they were common. At-sea surveys occasionally observed singles sat on the sea or flying, mainly while travelling to chumming locations.

Brown Booby *Sula leucogaster*.—Surveys at Marotiri found an adult and immature on 24 October and ten birds on 24 November. An adult was in the harbour at Rapa on 25 October and two were at Seamount 1 on 12 November. A vagrant to Rapa and Marotiri (Thibault & Cibois 2017). Our surveys indicate that presumably *S. l. plotus* is a scarce but regular visitor, not a vagrant.

Arctic Skua *Stercorarius parasiticus*.—Singles at Seamount 1 on 12 November and 29 November are the first records for Rapa and Marotiri. No previous records for the Austral Islands, with only two specimens from 1921 for East Polynesia (Thibault & Cibois 2017).

Discussion

WHITE-FACED STORM PETREL *Pelagodroma marina*

The taxa likely to occur in the region breed in Australasia (*P. m. albiclunis*, *P. m. dulciae*, *P. m. maoriana*), and all birds seen well or photographed during our survey were identified as involving one or other of these taxa, with a sullied pale greyish rump and large, but not deep, dark breast-side patches (Fig. 6). None of the six was in wing moult. No data exist on the subspecies previously recorded in East Polynesia.

During the non-breeding season (April–September) presumed representatives of Australasian populations move as far east as the coast of western South America (Spear & Ainley 2007). Thibault & Cibois (2017) thus reasoned that migrants must pass through East Polynesia. However, all records in East Polynesia, including during our survey, are during the breeding season (October–March) of the two taxa with large populations, *P. m. dulciae* (500,000 pairs nest in southern Australia; Baker *et al.* 2002) and *P. m. maoriana* (*c.*1 million pairs in New Zealand; Taylor 2000). Records in the Austral Islands involve our six in November, one off Rapa in December 1989, five near Marotiri and one south



Figure 6. White-faced Storm Petrel *Pelagodroma marina*, off Rapa, Austral Islands, French Polynesia, December 2019; note combination of sullied pale greyish rump, moderately developed dark breast-side patches, and clean white underparts (Tubenoses Project © H. Shirihai)

of Rapa / Marotiri in September 2006, and a live bird and a dead individual on Rurutu Island in October 2010 (Thibault & Cibois 2017). Seven more records (of ten individuals) are available from across East Polynesia, including an undated sighting for the Line Islands (Thibault & Cibois 2017).

Presumably, these birds were all or mainly non-breeders (i.e., adults that did not attain breeding condition and / or younger pre-breeders) given the dates and distance from Australasia. Thus, White-faced Storm Petrel utilises waters off Rapa and Marotiri on passage *and* during the breeding season.

Conservation status: Least Concern. Reportedly, populations of *P. m. dulciae* and *P. m. maoriana* are substantial, but the identity of birds off Rapa and Marotiri requires confirmation to eliminate *P. m. albiclunis*.

WHITE-BELLIED STORM PETREL *Fregatta grallaria*

Titan Storm Petrel *F. [g.] titan* is an endemic breeder at Rapa. It nests on five islets—Tarakoi, Rapa iti, Tapiko, Karapoo iti, Rarapai (400–1,000 pairs in 1990; Thibault & Cibois 2017), and probably at Marotiri. The discovery of substantial nocturnal activity around the clifftops on Rapa itself strongly suggests breeding there (Shirihai 2020a). Numbers at sea were larger than expected given that numbers nesting on islets off Rapa are reportedly rather small (Holyoak & Thibault 1984, Thibault & Varney 1991), which could be explained by a breeding population on the main island of Rapa.

The at-sea distribution of Titan Storm Petrel beyond Rapa and Marotiri is virtually unknown (Thibault & Cibois 2017). One was collected at 05°N, 140°W in November 1988 (Spear & Ainley 2007: 46) and one was collected by R. H. Beck at 04°20'S, 93°30'W, c.220 nm south-west of the Galápagos Islands in June 1906 (Murphy 1936: 762), with both identifications based on mensural data. There is no solid evidence for which taxon or taxa



Figures 7–10. ‘Classic’ Titan Storm Petrels *Fregetta [grallaria] titan*, Rapa Island, Austral Islands, French Polynesia, November–December 2019 (Tubenoses Project © H. Shirihai). The plumage of ‘classic’ *titan* includes broad white fringes to the scapulars, mantle to rump, and upperwing greater, median and longest lesser secondary-coverts. Fig. 7 offers a closer look at the broad white fringes to the mantle to rump feathers, which are abraded and worn off on a few old, browner feathers. The bird in Fig. 8 has undergone head and body moult, with blackish-grey scapulars and mantle to rump, strongly contrasting with the mainly old, browner upperwing-coverts without white fringes. Note the sparse dark streaking on the body-sides in Fig. 8, but lacking in Fig. 10.

occur/s in East Polynesia away from Rapa and Marotiri, but Titan Storm Petrel apparently disperses a significant distance given these two records from much further north and east.

Titan Storm Petrel is one of the white-bellied *Fregetta* storm petrel complex, but is exceptionally large, approaching the size of the local Polynesian Storm Petrels, when observed side by side over chum (note, Polynesian Storm Petrel of the Austral and Gambier Islands is larger than those from the Marquesas; Holyoak & Thibault 1984). In addition to size, Titan Storm Petrel has particularly broad white fringes to the scapulars, mantle to rump, and greater, median and longest lesser secondary-coverts (Figs. 7–9). However, recent research (summarised below) indicates that Titan Storm Petrel is not the only taxon

of *F. grallaria* to show such broad white fringes. Thus, by itself, large white fringes is not a diagnostic field mark of Titan Storm Petrel.

Fregetta taxonomy is unresolved (Cibois *et al.* 2015, Robertson *et al.* 2016). The *F. grallaria* complex may comprise as many as twice the four currently recognised taxa: *F. [g.] leucogaster*, which breeds alongside the almost identical-looking white-bellied Black-bellied Storm Petrel *Fregetta tropica melanoleuca*, with a combined population of c.61,000 pairs nesting on Inaccessible and Nightingale Islands, in the Tristan da Cunha group, and on nearby Gough, central South Atlantic (Ryan 2007); *F. [g.] grallaria*, with 2,000 pairs breeding on Lord Howe and in the Kermadec Islands, south-west Pacific (Taylor 2000); *F. [g.] titan*, an endemic breeder at Rapa and Marotiri, central South Pacific; *F. [g.] segethi*, of which a few hundred pairs breed in the Juan Fernández and Desventuradas Islands, south-east Pacific (Brooke 2004). However, the population of *F. [g.] segethi* must be considerably larger based on counts at sea, e.g. c.600 on 8 November 2014, attracted by dripping fish oil between Robinson Crusoe and Alexander Selkirk Islands (Shirihai *et al.* 2016, Flood *et al.* 2017).

During the current survey, HS analysed variation of *F. grallaria* off Rapa, irrespective of the impacts of wear and abrasion, as follows.

'Classic' broadly fringed *F. [g.] titan* (Fig. 11). Broad white fringes to the scapulars, mantle to rump, and greater, median and longest lesser secondary upperwing-coverts. Some variation was noted in the width of the white fringes. Several had admixed contrasting new and old feathers, the latter being brownish with abraded narrower fringes.

Indistinctly fringed *F. [g.] titan* (Fig. 12). Scarce among *F. grallaria* off Rapa and Marotiri, and mostly observed in November. Compared to 'classic' individuals, had much narrower white fringes to the same feathers, including newly moulted ones, looked less heavily built, but not necessarily smaller, and had a slimmer but similar-length bill. This could be interpreted as variation among Titan Storm Petrels, being for example age-related, although contrasting feather bleaching and abrasion compared to 'classic' birds suggests that these birds may not be from the same population. Alternatives are the possibility of two seasonal populations of Titan Storm Petrel or another taxon of *F. grallaria* nesting on or visiting Rapa's islets or Marotiri. An apparently greater proportion of indistinctly fringed birds was observed at Marotiri compared to Rapa; for example, on 24 November off Marotiri, 5–10 were estimated among c.60 of the species, whereas on 29 November at Seamount 1 there was just two among c.55. To our knowledge, all museum specimens of Titan Storm Petrel are from Rapa and no *F. grallaria* has been collected at Marotiri.

We detected several other variations off both Rapa and Marotiri. Some individuals have sparsely distributed fine streaks on the body-sides or 'bleeding' from the dark hood onto the lower breast, or in the shorter undertail-coverts (Fig. 8 vs. Fig. 10). The thighs occasionally show such streaking or more extensive dark smudging. Clean white longest uppertail-coverts occur on most birds; others have white-fringed, small to large, dark subterminal marks in the central four uppertail-coverts and dark shaft-streaks on some or the rest of the uppertail-coverts; the remainder are intermediate. In the underwing, the outermost greater primary-coverts are dark with pale fringes; dark centres typically reduce in size towards the inner coverts and shrink in size at the base, minimally involving the outermost five coverts, but in some birds all of these feathers are largely dark. Similar patterns were noted for the underwing median primary-coverts. Hence, the extent of the white panel in the underwing-coverts is variable in the outer wing. None of the birds was in wing moult, but some had undertaken head and body moult, suggesting a protracted or bimodal breeding activity.

During 2013–17, we organised expeditions to the Juan Fernández and Desventuradas groups in the East Pacific to study *F. [g.] segethi*. The evidence indicates variation in size and plumage, and up to five different 'types' as follows: two at Robinson Crusoe Island



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12



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Figures 11–13. White-bellied Storm Petrels *Fregetta grallaria*. ‘Classic titan’ (Fig. 11) and ‘variant titan’ (Fig. 12), Rapa Island, Austral Islands, French Polynesia, December 2019; and ‘variant segethi’ (Fig. 13) with white fringes like ‘classic titan’, off the Desventuradas Islands, Chile, February 2017 (Tubenoses Project © Hadoram Shirihai)

(Shirihai *et al.* 2015a, Flood *et al.* 2017), one at Alexander Selkirk Island, and two at the Desventuradas. Some ‘types’ may represent seasonally divided populations, and others may warrant taxonomic recognition (HS, H. Diaz & VB work in progress). The variant at the Desventuradas is of particular interest herein; it is the smallest and palest form, and has Titan-like broad white fringes to the scapulars, mantle to rump, and upperwing greater, median and longest lesser secondary-coverts (Fig. 13). HS noted birds that conform to this ‘type’ in 2003 in the Humboldt Current, far from the Desventuradas, suggesting that it disperses or is migratory (Shirihai 2007: 212).

These findings complicate matters and make at-sea recognition of Titan Storm Petrel more challenging. Away from Rapa and Marotiri, great caution must be exercised before assigning any *F. grallaria* to Titan Storm Petrel. Based on current knowledge, only birds proven to be both exceptionally large *and* to have the requisite broad white feather fringes can be presumed to be Titan Storm Petrel.

F. grallaria is listed as Least Concern, but the distinctive ‘classic’ Titan Storm Petrel, if treated separately, might be considered threatened. When breeding, ‘classic’ Titan Storm Petrel evidently forages in substantial numbers near Rapa and Marotiri, but not far beyond them in regions covered by the *Sauvage* expedition (Flood & Zufelt 2021). Protection of the breeding islets, rocks, and adjacent waters, including key foraging locations like Seamount 1, is imperative for the taxon’s survival.

POLYNESIAN STORM PETREL *Nesofregatta fuliginosa*

Breeds across the South Pacific, with an estimated total population of 10,000 mature individuals (Brooke 2004, Thibault & Cibois 2017). Seasonal in the East Pacific, with a large estimate of between 21,000 and 52,000 birds there (Spear & Ainley 2007). Breeds on Rapa’s islets, Karapai and Tarakoi, with an estimated 35–198 pairs (Thibault & Varney 1991), and nesting is likely at Marotiri (Thibault & Cibois 2017). Our large counts close to Rapa conflict with these low breeding estimates, and our large counts near Marotiri suggest nesting there, which could represent a significant additional population for this species. The small



Figures 14–16. Polynesian Storm Petrels *Nesofregatta fuliginosa*, Rapa Island, Austral Islands, French Polynesia, December 2019 (Tubenoses Project © H. Shirihai). Unique ‘bicoloured’ plumage, with a blackish-brown hood and broad dark breast-band separated by a white ‘cut-throat’, narrow white crescent on the tail base, and pale wingbar tipped with buff. We noted two main variations. Some show sparse and narrow dark streaks on the otherwise white body-sides (Figs. 15–16). The number of underwing greater primary-coverts that are dark with white fringes varies from the four outermost (Fig. 15) to all of them (Fig. 16), but in the latter case on the innermost coverts the dark area is paler and the white fringes broader.

numbers per day in November–December indicate that many had moved away from the region, consistent with the cessation of breeding activity.

Classed as monotypic by most key works (e.g. Carboneras *et al.* 2020a) and polymorphic, with exclusively pale-morph individuals at Rapa and Marotiri (Figs. 14–16). During our survey, size variation was apparent within flocks of birds. We also noted plumage variation. Some have sparsely distributed narrow dark streaks along the white body-sides (see Figs. 15–16). Underwing greater primary-coverts vary too, from the outermost four being dark with broad white fringes and the rest white, to all coverts dark with thick white fringes, although the innermost ones typically are somewhat faded (Figs. 15–16). These variations may be related (but requires further research). None was in wing moult, but the remiges and rectrices of some birds were heavily worn, consistent with individuals at the end of the breeding season.

Conservation status Endangered. The number of historically extinct populations in East Polynesia is shocking (see Thibault & Cibois 2017: 135). Good numbers at sea at Marotiri and off Rapa is thus an important discovery.

BULLER'S ALBATROSS *Thalassarche [bulleri] bulleri / platei*

Southern Buller's *T. [b.] bulleri* breeds on the Snares and Solander Islands (c.11,500 pairs, January–September; Brooke 2004), whilst Northern Buller's *T. [b.] platei* nests in November–June mainly on the Chatham Islands (c.18,000 pairs; Brooke 2004). Post-breeding, they disperse east across the South Pacific and are regular in the Humboldt Current off Chile and Peru (BirdLife International 2020), where both adults and immatures occur (Shirihai *et al.* 2016, Flood *et al.* 2017), *contra* Marchant & Higgins (1990). Thibault & Cibois (2017) noted five records for East Polynesia, none assigned to taxon, including one at sea in October 2014 between Marotiri and Rapa. All sightings, including our two, are in September–November, consistent with birds returning to their colonies to breed. Our birds were not in wing moult. Buller's Albatross is probably regular seasonally in small numbers off Rapa and Marotiri. Sightings in East Polynesia are limited to subtropical waters, including the seas around Rapa and Marotiri, which potentially are important to this species. The two taxa combined are listed as Near Threatened.

MURPHY'S PETREL *Pterodroma ultima*

Endemic breeder in East Polynesia south of 17°S, with regular colonies in the Austral Islands. Breeds March / April–October, with slight differences in laying dates between locations (Thibault & Cibois 2017). On average, birds depart their breeding sites on 22 October ± 18 days and spend the non-breeding season mainly in the Subarctic Gyre in the North Pacific, foraging in cool mesotrophic waters (Clay *et al.* 2017). Recorded east to the Juan Fernández Islands (Flood *et al.* 2016b). Thus, our sightings in December, although few, are noteworthy. Further, HS observed several displaying birds visiting the seabird colony on Tautourau in December, suggesting that some are resident.

The total population is estimated at 800,000–1,000,000 individuals (Brooke 2004). Hundreds of pairs are said to breed at Marotiri, with small numbers on Rapa's islets (Thibault & Cibois 2017), specifically 10–99 pairs (Thibault & Varney 1991). However, all previous visits to Rapa were in November–April, i.e. mostly outside the breeding season. The number at Rapa and Marotiri is a small proportion of the total, but represents an important satellite population in the far south-west of the species' breeding range, given the conservation status Near Threatened. There was no indication of morphological differences between those observed at Rapa and Marotiri vs. elsewhere in East Polynesia, and none was in wing moult.



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Figures 17–18. Juan Fernández Petrels *Pterodroma externa*, Rapa Island, Austral Islands, French Polynesia, December 2019 (Tubenoses Project © H. Shirihai). Unlike the White-necked Petrel *P. cervicalis* complex, *externa* shows at most only a scruffy white neck collar when these feathers are heavily worn and faded (probably most typical of old juvenile feathers) but, as here, the vast majority lack a collar. The inner underwing has a dark comma-shaped mark at the carpal joint, unlike the extended ulnar bar of the White-necked Petrel complex.

JUAN FERNÁNDEZ PETREL *Pterodroma externa*

Endemic breeder on the Juan Fernández Islands, in December–May (*c.* 1 million pairs; Brooke 2004). Post-breeding it undertakes northward trans-equatorial migration (Carboneras *et al.* 2020b). However, moderate numbers that we logged off Rapa and Marotiri, mainly over seamounts and often associated with seabird feeding frenzies, and the records listed below, provide evidence that it also regularly ranges westward at mid latitudes. This may explain long-distance vagrancy to New Zealand (e.g., Reed 1976, Imber *et al.* 1991, Miskelly *et al.* 2006) and even Tristan da Cunha and Gough in the South Atlantic (Matthews 1932, Speight 2010).

Thibault & Cibois (2017) noted 13 reports, some involving multiple individuals, of White-necked *P. cervicalis* or Juan Fernández Petrels in East Polynesia, remarking that their at-sea separation is problematic (but see Figs. 17–18). We found four previous reports of *P. externa*: one in May 1990 between the Line and Society Islands (Phillips & Wragg 1993), one in March 2003 between Manuhangi and Reitoru in the Tuamotus (VanderWerf 2006), several tens in November 2014 between Gambier and Pitcairn (C. Collins unpubl.), and 13 in December 2013 on leaving Rapa Nui, Eastern Islands, towards Punta Arenas, Chile (Fraser 2014). Observations in November, December, March and May, i.e. throughout the breeding season of *P. externa*, is evidence that at least some are non-breeders, probably immatures, while breeders may visit, for example, during the pre-laying exodus. Evidently, Juan Fernández Petrel is a regular visitor to Rapa and Marotiri, and East Polynesia more generally.

Conservation status Vulnerable. We have shown that the seas around Rapa and Marotiri are important for Juan Fernández Petrel. Seamount 1 was a favoured foraging area with conservative counts of 15–20 per day on three occasions. We found no indication

of morphological differences between Juan Fernández Petrels observed around Rapa and Marotiri, and the Juan Fernández Islands, and none was in wing moult.

KERMADEC PETREL *Pterodroma neglecta*

In the Pacific, breeds mainly November–May, from Lord Howe Island in the west, east to Easter Island, the Juan Fernández and Desventuradas Islands (150,000–200,000 birds; Brooke 1987, 2004). Recently, a substantial population was found on San Ambrosio Island (22,686 pairs in accessible areas; Marín *et al.* 2020). Rapa and Marotiri represent relatively small but important breeding sites, with *c.*1,000 pairs (Thibault & Cibois 2017). Ranges across the tropical and subtropical Pacific. Rapa and possibly Marotiri are the only islands in the Austral group with regular breeding. The 19 that we observed at Rapa on 25 October suggest nesting was underway by late October.

Considered polytypic by some authorities, with *P. n. juana* in the south-east Pacific (e.g., Brooke 2004, Carboneras *et al.* 2020c). However, recent studies of genetics (Jones *et al.* 2017) and biometrics (VB unpubl.) indicate that *P. n. juana* is not a valid taxon. We found no indication of morphological differences between Kermadec Petrels observed around Rapa and Marotiri, and elsewhere in the Pacific, and none was in wing moult.

The wide range of plumage variation in Kermadec Petrel may be categorised into morphs—light, intermediate, and dark, and subdivided into colours (Shirihai & Bretagnolle in prep.). Light morph is subdivided into white, white-bellied and mottled types; and dark morph into rufous, brown, grey-brown, and grey types, mostly based on belly coloration but also that of other ventral and dorsal regions, including underwing-coverts. Intermediates are not subdivided. Such work with Kermadec Petrels at Rapa (*n* = 135 birds) is the last step in categorisation of populations across the species' range. The most interesting differences from other populations (Table 2) are the rather high percentage of grey-brown birds (24.5%), no rufous birds (0%), and a reasonable number of the generally rare white type (8.9%).

Conservation status Least Concern. Encountered foraging in all directions off Rapa, indicating that the entire marine area around the island is of importance to the species.

TABLE 2
Plumage colour categorisation for Kermadec Petrel *Pterodroma neglecta*, with eight morph types, showing the percentages for each at Rapa Island and Marotiri Rocks (*n* = 135 birds).

Morph Type	Light			Intermediate	Dark			
	white	white-bellied	mottled		rufous	brown	grey-brown	grey
%	8.9	13.3	11.1	17.8	0	13.3	24.5	11.1

MOTTLED PETREL *Pterodroma inexpectata*

Breeds abundantly in December–May on islands south of New Zealand from where it undertakes trans-equatorial migration to the Bering Sea (Brooke 2004). The two seen during our survey presumably were breeders returning to New Zealand to breed. These sightings add to the evidence that *P. inexpectata* is at least occasional on passage in the central South Pacific and is not a vagrant (e.g., records in Marchant & Higgins 1990, Thibault & Cibois 2017), although not previously recorded in the Austral Islands (Thibault & Cibois 2017). Conservation status Near Threatened, but East Polynesia evidently is of only marginal importance to the species. No indication of morphological differences with birds observed off New Zealand and in the Bering Sea. Neither bird was in wing moult.

BLACK-WINGED PETREL *Pterodroma nigripennis*

Breeds mid November to May in the Tasman Sea area, Kermadec Islands, New Caledonia, and in the Chatham Islands (8–10 million birds; Brooke 2004). Breeds on two islets off Rapa—Rapa iti and Tauturau (c.1,000 pairs in 1989–90; Thibault & Cibois 2017), and probably Marotiri where sightings on 24 November corroborate those during the Whitney South Sea Expedition (R. H. Beck ms). None recorded during our survey in October at either Marotiri or Rapa, just prior to the onset of nesting, is consistent with total absence from colonies during the austral winter (Hutton & Priddel 2002). Numbers at sea off Rapa were smaller than expected for a breeding population of c.1,000 pairs. A few tens of pairs were discovered on Raivavae Island, Austral group, in December 2019 (Shirihai 2020b), which, after Rapa, is only the second known breeding location in East Polynesia. Widespread across the tropical and subtropical Pacific in the non-breeding season.

Black-winged Petrel is one of very few *Pterodroma* and one of just two Cookilaria petrels (the other being De Filippi's Petrel *P. defilippiana*) to exhibit diurnal activity at its colonies (McKown 2008). On 5–6 December, dates coincident with the start of the breeding season, HS camped near the main colony of Black-winged Petrels, just below the summit of Tauturau iti, aiming to record the birds' display flight characteristics. HS made a rough estimate of up to 500 birds, many paired, probably involving 200 or more pairs. They frequented two main areas, mostly separated from the main nesting sites of Kermadec Petrel, though some nests of the two were in close proximity. Fewer pairs of Murphy's Petrel frequented the middle ground. One of the main Black-winged Petrel clusters was in vacated burrows of Rapa Shearwater in low scrub forest (Thibault & Varney 1991). Many of the other Black-winged Petrel pairs utilised shallower burrows or partially sheltered locations, below rocks and scrub. Nest sites were easily located by shouting and listening for an assured response from occupied burrows. Black-winged Petrel displayed day and night, but the peak period was roughly 17.00–20.00 h. Up to 40 at a time performed aerobatic displays, in pairs or groups of up to nine, at a range of heights. Several slow-moving pairs or small groups repeatedly flew low over nest sites, even passing between bushes. At night, numerous pairs displayed and socialised over open ground.

Behaviour around unoccupied burrows of Rapa Shearwater differed compared to a visit there on 27 November, when Black-winged Petrel pairs mostly displayed on the ground outside burrows. They were occupied in pairing and burrow preparation, which probably started mid November, based on a visit on 21–22 November to the other breeding islet, Rapa iti. Thus, egg laying around Rapa is roughly aligned with most other populations (e.g. late December on Lord Howe; Hutton & Priddel 2002), with a poorly defined pre-laying exodus, or not all birds undertake this.

Conservation status Least Concern. However, Rapa is the easternmost confirmed nesting site and represents something of an outpost in the breeding range. No indication of morphological differences with birds from the Kermadec Islands (Holyoak & Thibault 1984) or elsewhere (pers. obs.), and none was in wing moult.

GOULD'S PETREL *Pterodroma leucoptera*

The nominate subspecies breeds between late November and April off central New South Wales, Australia (c.1,000 pairs; Priddel & Carlile 2007, 2009), whilst *P. [l.] caledonica* nests on New Caledonia (1,000–10,000 pairs; Brooke 2004). On the evening of 6 December, two were seen close to Rapa, giving the impression of being local breeders. The non-breeding range extends to the tropical East Pacific (Priddel *et al.* 2014, Rayner *et al.* 2016). Our survey demonstrated that Gould's Petrel also utilises the subtropical central South Pacific. Not included in Thibault & Cibois (2017).

The identity of the little-known Raivavae *Pterodroma* is treated as uncertain, or as Collared Petrel *P. brevipes* (Brooke 2004, Thibault & Cibois 2017). Population size and trends are poorly known, but 10–15 birds have been noted (Gangloff *et al.* 2007). However, there was no evidence of Collared Petrel on Raivavae in December 2019. Adding to the puzzle, a few tens of pairs of Black-winged Petrel were recorded there (Shirihai 2020b). The identity of petrels breeding on Raivavae, and perhaps the same species on Rapa, is under investigation (VB & HS). Findings to date confirm that Gould's Petrel and possibly Collared Petrel previously bred on Raivavae, but it is unclear which subspecies of Gould's Petrel was involved, *P. [l.] leucoptera*, *P. [l.] caledonica*, or perhaps an undescribed taxon confined to French Polynesia. Any Gould's Petrels breeding on Rapa could be the last survivors of a discrete population. However, we observed no morphological differences compared to birds observed off Australia. None was in wing moult.

Conservation status Vulnerable. Given this, our sightings highlight the importance of the subtropical ocean off Rapa and tropical East Polynesia for Gould's Petrel.

STEJNEGER'S PETREL *Pterodroma longirostris*

Breeds in the Juan Fernández Islands, in December–April (*c.*131,000 pairs; Brooke 2004), after which it migrates to the subtropical north-west Pacific (Brooke 2004). Like Juan Fernández Petrel, the moderate numbers logged during our survey, along with other records in East Polynesia (Thibault & Cibois 2017), provide evidence that Stejneger's Petrel disperses regularly westwards at mid latitudes. This may explain records as far from the Juan Fernández Islands as eastern Australia and northern New Zealand (e.g. Marchant & Higgins 1990), and even the North Atlantic (Lockwood 1999). Not previously recorded in the Austral group (Thibault & Cibois 2017). Our sightings highlight the importance of the seas off Rapa and in tropical East Polynesia to the species. Conservation status Vulnerable. No morphological differences observed vs. birds at the Juan Fernández Islands, and none was in wing moult.

TAHITI PETREL *Pseudobulweria rostrata*

Year-round breeder, with *P. r. rostrata* nesting in the tropical eastern South Pacific, and *P. r. trouessarti* in the western South Pacific (combined total population *c.*10,000 pairs; Brooke 2004). All those we observed had essentially uniform dark underwings, typical of eastern populations. Breeds on Raivavae, Austral Islands (no population estimate; Thibault & Cibois 2017). Ranges to the subtropical Pacific (Brooke 2004). Conservation status Near Threatened. That said, our survey confirms that subtropical Rapa and Marotiri are unsuitable and of little importance to Tahiti Petrel. None was in wing moult.

GREY PETREL *Procellaria cinerea*

Breeds on subantarctic islands in March–October (*c.*400,000 birds; Brooke 2004) in cool temperate waters at 37–49°S, and ranges widely in subtropical and subantarctic waters, mainly at 30–60°S (Marchant & Higgins 1991). Previous records for Rapa and Marotiri involve one attracted to chum off Marotiri, and one further south at 29–30°S, both in September 2006, with just two additional records for East Polynesia (Thibault & Cibois 2017). Our sightings demonstrate that Grey Petrel is regular off Rapa, which is noteworthy given its conservation status (Near Threatened). Seamount 1 proved to be a particularly important foraging area. No morphological differences with those observed at many other locations, including the South Atlantic, and none was in wing moult.

BLACK PETREL *Procellaria parkinsoni*

Breeds in November–May in the Hauraki Gulf, New Zealand, where ongoing conservation efforts are underpinning a significant recovery in numbers (c.2,750 pairs; Richard & Abraham 2015). Migrates to the East Pacific, reaching southern Mexico to northern Peru (Brooke 2004). Regularly seen during a trip from Gambier to the southern Austral Islands in September 2006, including up to 12 together (Thibault & Cibois 2017). Our sightings demonstrate the species is regular off Rapa, which is noteworthy given its conservation status (Vulnerable). Seamount 1 again was the main point of concentration, underlining its importance. No morphological differences with those observed on the breeding grounds in New Zealand, and off the west coast of South America, and none was in wing moult.

WEDGE-TAILED SHEARWATER *Ardenna pacifica*

Breeds across the tropical and subtropical Pacific and Indian Oceans (5.2 million pairs; Brooke 2004, Whittow 2020). Nesting in northern and southern parts of the range is mainly during the regional summer, but tropical populations are aseasonal. Several pairs to hundreds of pairs nest in the northern Austral Islands, but none at Rapa or Marotiri (Thibault & Cibois 2017). Post-breeding, subtropical populations tend to move to tropical waters, whereas tropical breeders are largely sedentary (Flood & Fisher 2020). Conservation status Least Concern. Nevertheless, the ocean around Rapa and Marotiri is an important feeding area, presumably for breeders from the northern Austral Islands, though possibly also from elsewhere. No morphological differences with those seen elsewhere in the South Pacific, and none was in wing moult.

BULLER'S SHEARWATER *Ardenna bulleri*

Breeds in September–May off North Island, New Zealand (c.200,000 pairs), with egg laying in November / December, then undertakes a clockwise trans-equatorial migration (Marchant & Higgins 1990, Brooke 2004). Presumably mostly immatures occur off western South America, in March–July. Given the distance from Rapa to New Zealand, it is unlikely that birds observed during our survey were on pre-laying exodus, so they were non-breeders, probably mainly immatures. Not mentioned in Thibault & Cibois (2017). Conservation status Vulnerable and our sightings highlight the importance to the species of the subtropical seas off Rapa. No indication of morphological differences with those observed elsewhere in the Pacific and none was in wing moult.

SOOTY SHEARWATER *Ardenna grisea*

Breeds in south-east Australia, New Zealand, southern Chile and the Falkland Islands, in late September to late April / early May (c.20 million pairs; Brooke 2004). Post-breeding, undertakes a trans-equatorial migration in the Atlantic and Pacific (Brooke 2004). Previous records for the Austral Islands in March and April 1921, between Rapa and Rurutu Island to the north, and two singles south of Marotiri in September 2006 (Thibault & Cibois 2017), but regularly seen during our survey. Given the distance from Australasia, those observed around the Austral Islands in the breeding season presumably are non-breeders, probably mainly immatures. Conservation status Near Threatened. Rapa and Marotiri apparently are of marginal importance given the relatively small numbers recorded. No indication of morphological differences with those observed elsewhere and none was in wing moult.

CHRISTMAS SHEARWATER *Ardenna nativitatis*

North and South Pacific breeding populations (total c.50,000 pairs; Brooke 2004). Breeds on Marotiri and Rapa (100–999 pairs; Thibault & Cibois 2017). Southern birds breed October–

March then migrate to Middle America (Thibault & Cibois 2017). Conservation status Least Concern. Even so, perhaps 2% of the total population and 10% of that in East Polynesia nests on Rapa and Marotiri, representing a significant site for southern breeders. None was in wing moult.

RAPA SHEARWATER *Puffinus myrtae*

Conservation status Critically Endangered. Breeding at Rapa is seasonal, with birds present April to mid November (Holyoak & Thibault 1984) on the eastern and southern islets of Tauturau (200–300 pairs), Rapa iti (40–50 pairs) and Karapoo iti (*c.*10 pairs; estimates from Thibault & Varney 1991). The population today is severely reduced (Thibault & Withers 2019). Only one seen in the immediate vicinity of Marotiri in September 2006 (Gaskin *et al.* 2006) where it possibly breeds, but there are no population surveys (Thibault & Cibois 2017). Range beyond Rapa and Marotiri unknown, except for one bird fitted with a data logger that foraged far south and south-east of Rapa (Withers *et al.* 2020).

During our survey, individuals seen at dawn east of Rapa were flying away from the island, and the bird at dusk was flying towards it, behaviour typical of adults feeding young. None was in wing moult. A fresh juvenile observed at sea on 16 November and three grounded juveniles found on Rapa during 18–20 November confirm fledging around mid November (Shirihai 2020a). None was seen at breeding sites in December (Thibault & Varney 1991, Shirihai 2020a). Breeding phenology based on dated and aged specimens discussed in Shirihai *et al.* (2017), but below we revise their diagnosis of the Rapa Shearwater type and describe the correlation between progress of the breeding season and plumage variation.

Specimens were described in Shirihai *et al.* (2017), whereas the following is based on pelagic observations, which were brief and often in dull light, and a few at-sea photographs. **Structure** Relatively short and very slender bill set low on face. Front-end projection (less bill) *c.*65% that of caudal projection (rear body and tail behind wings). Elongated rear section includes a long, strongly graduated tail (Figs. 19–21). Fairly long slim body, fairly long narrow wings, not strongly angular at the carpal joint, and wingtips slightly blunt. **Plumage and bare parts** Diffusely bicoloured bill. ‘Bicoloured’ plumage with clear-cut border between dark upper- and white underparts. Dorsally blackish grey with variable bluish hue. Crown purer black, forming dark cap contrasting with dark grey forehead, which just reaches base of nasal tubes. Blackish-grey hindneck extends laterally a short way around neck, thus neck-sides extensively white, and breast-side patches poorly developed (i.e., shallow blackish-grey extension under forewing onto fore-flanks, short of upper breast). Broad white ‘supercilium’ separates cap from eye and merges with white ear-coverts to form extensive white head-sides, usually with an ill-defined dusky loreal mark that may connect to front of cap. In accordance with Shirihai *et al.* (2017), the upperwing-coverts appeared to lack or had mostly worn off white fringes (adults), except the individual on 16 November which had white-fringed upperwing-coverts (juvenile). Although mainly seen in dull light, the larger coverts of the inner upperwing occasionally formed a pale panel suggesting a reflective surface (like Barolo Shearwater *P. baroli* in the North Atlantic; Flood & van der Vliet 2019, Flood & Fisher 2020). Small white ‘saddlebags’ (formed by white feathers that wrap over from the underside onto the upperside, rear of the wings). Chin to undertail-coverts clean white. Underwing-coverts largely white, marginal coverts dark, short lesser primary-coverts with ‘dark centres’ forming a checkered appearance, same with short lesser secondary-coverts, central long lesser secondary-coverts with ‘dark centres’ forming a shallow dark ‘V’ in the central inner forewing. Underside of primaries dark with white ‘tongues’ basally that extend along inner web, most obvious on outermost primaries, with length of ‘tongues’ on pp8–10 up to 50% length of visible feather. **Flight behaviour**



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Figures 19–21. Rapa Shearwaters *Puffinus myrtae*, off Rapa Island, October 2019; note distinctly long caudal projection, and extensive white face, undertail- and underwing-coverts, and bases to the underside of the primaries (Figs. 19 and 21: Kirk Zufelt; Fig. 20: Mike Danzenbaker)

Reminiscent of Subantarctic Shearwater *P. elegans*, fast and direct, propelling itself forward, rather than using wind to arc and shear, with short glides, occasional mainly low ascents, tilting and occasionally banking.

Taxonomy not fully resolved. Rapa Shearwater was described by Bourne (1959). A genetic study by Austin *et al.* (2004) surprisingly found *P. myrtae* genotypically close to the phenotypically different Newell's Shearwater *P. newelli*. More recently, Martínez-Gómez *et al.* (2015) recommended that Rapa Shearwater be ranked at species level. Shirihai *et al.* (2017) confirmed the identity of the *P. myrtae* holotype. However, several morphological discrepancies were found between the type specimen and more recently collected specimens by J.-C. Thibault from Tauturau iti held at the Muséum national d'Histoire naturelle, Paris. These discrepancies are best considered to result from differences in specimen preparation or are age-related, the latter not fully understood until now.

In addition to the above description of Rapa Shearwater at sea (RLF & HS), VB & HS rechecked many images of the *P. myrtae* type, as well as others of several adults from the nesting season (taken in August 2019; Thibault & Withers 2019) and several recently fledged juveniles (November–December 2019; HS). First, we conclude that the *P. myrtae* type is not a juvenile as proposed in Shirihai *et al.* (2017), but a very fresh adult, as originally suggested by Bourne (1959), *contra* Shirihai *et al.* (2017). Secondly, we now have a clearer understanding of plumage variation in relation to the breeding phylogeny of this shearwater. Adults have fresh plumage at the start of the breeding season in April. The upperparts show a bluish-grey tinge with a marbled effect to the mantle, back and some upperwing-coverts, because the feathers are pale grey basally, with an ill-defined darker grey subterminal area, and tipped whitish. The upperwing-coverts have broad white fringes. As the season progresses, notably from August, the upperparts bleach browner and white fringes to the upperwing-coverts wear off; by its end, in October, the white fringes are largely lost, leaving the dorsal surface near-uniform blackish brown. Fresh juvenile feathers on the upperparts are largely uniform blackish, but appear bluish black when reflecting light, and the upperwing-coverts have broad white fringes. Juveniles do not show the marbled effect that characterises fresh adults. On fledging, fresh blackish juvenile plumage is unlike the worn and bleached browner adults, as in other shearwaters such as Tropical *P. bailloni* and Yelkouan Shearwaters *P. yelkouan* (see Bretagnolle & Attié 1996).

Conclusion

Our survey adds substantial new information about seabirds to the biogeographic atlas for East Polynesia (Thibault & Cibois 2017) and we recommend that the regional occurrence of some species be modified. Of particular note, Gould's Petrel and Buller's Shearwater should be added to the region's avifauna, and the following species to the list for the Austral Islands: Juan Fernández, Mottled and Stejneger's Petrels. Arctic Skua is new to the avifauna of Rapa and Marotiri. The regional occurrence of Brown Booby at Rapa and Marotiri should be modified from vagrant to a scarce but regular visitor. Seasonally regular tubenoses of conservation concern shown to occur in small to moderate numbers offshore are Juan Fernández, Gould's, Stejneger's and Black Petrels, and Buller's Shearwater. Further seabird taxa may visit especially in months not covered by our survey.

An important finding for Polynesian Storm Petrel, given the species' decline, is a possible hitherto unrecognised population breeding at Marotiri and evidence of healthy numbers on Rapa. Chumming sessions attracted many hundreds and we documented plumage variation.

Titan Storm Petrel may breed on Rapa as well as its islets. When breeding, it forages to at least 15 nm off Rapa, often alongside Polynesian Storm Petrel. Chumming sessions attracted many hundreds of Titan Storm Petrel, making possible the first large-scale study of variation in structure and plumage. 'Classic' birds largely dominated, with broad white fringes to the scapulars, mantle to rump, and many secondary-coverts. However, we also noted a variant with narrower fringes and more lightly built bill and body, but not smaller in size. This may be explained by individual variation, two seasonal populations, or another taxon of *F. grallaria* visiting the region or breeding locally.

Two Gould's Petrel seen close to Rapa on the evening of 6 December behaved like local breeders. If they were, then they may represent remnants of an Austral Islands population (taxon unknown), given recent confirmation that the species previously bred (and may still do so) on Raivavae Island.

At-sea sightings of the Critically Endangered Rapa Shearwater are extremely rare. We found reliable areas from which to observe adults flying to the colony late evening and

departing it early morning, 10–15 nm south and south-east of Rapa. We report a sighting of an unidentified small *Puffinus* sp. at Marotiri on 23 November.

Our survey, combined with past research, offers much weight to the argument that the seas surrounding Rapa and Marotiri should be subject to conservation measures for breeding and visiting species, in addition to plans to eradicate invasive predators from the islands to protect breeding seabirds. This would promote conservation of the endemic Rapa Shearwater and Titan Storm Petrel, among other species, and globally threatened passage tubenoses.

Although our survey is the most extensive at-sea study in the region, there is still much to learn. Pelagic surveys in some of the nine months not covered by our work will help to refine knowledge about breeders, such as timing of nesting, and the regional and temporal occurrence of visiting seabirds. Further study of Titan Storm Petrel may explain the two ‘types’ seen off Rapa and Marotiri, and of White-faced Storm Petrel to shed light on which taxon (or taxa) visits the region. Wider searches may improve understanding of the foraging behaviour of Rapa Shearwater when breeding, including whether they exclusively head directly south and east of the colonies, as we found, or radiate in all directions from Rapa.

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Supplementary Information (as supplied by authors, online only): Detailed results for tubenoses (a complete set of counts) with notes on their behaviour and identification.

