Bird Conservation International

www.cambridge.org/bci

Tracking the non-breeding range of Rapa Shearwater *Puffinus myrtae*, a Critically Endangered seabird of the South Pacific Ocean

Frédéric Jiguet[1], Jean-Claude Thibault[2], Paul Dufour[3,4] and Tehani Withers[5]

[1]UMR7204 Centre d'Ecologie et des Sciences de la Conservation, MNHN, CNRS, Sorbonne Université, CP135, 75005 Paris, France; [2]Casa Verde, 20253 Patrimonio, France; [3]Tour du Valat, le Sambuc, 13200 Arles, France; [4]CEFE, CNRS, L'Université Montpellier, EPHE, IRD, 34090 Montpellier, France and [5]Société d'Ornithologie de Polynésie MANU, BP 7023, 98719 Taravao, Tahiti, French Polynesia

Short Communication

Cite this article: Jiguet F, Thibault J-C, Dufour P, Withers T (2024). Tracking the non-breeding range of Rapa Shearwater *Puffinus myrtae*, a Critically Endangered seabird of the South Pacific Ocean. *Bird Conservation International*, **34**, e34, 1–4
https://doi.org/10.1017/S0959270924000182

Received: 26 March 2024
Revised: 27 May 2024
Accepted: 18 June 2024

Keywords:
geolocator; light logger; fisheries-bycatch; introduced mammals; extinction

Corresponding author:
Frédéric Jiguet;
Email: frederic.jiguet@mnhn.fr

Summary

We report the non-breeding range of an adult Rapa Shearwater *Puffinus myrtae*, as estimated from data collected by one light logger deployed from 31 August 2019 to 22 July 2020. The Rapa Shearwater is classified as "Critically Endangered", with a strong decline in breeding numbers reported recently. As the species is threatened by various introduced mammals on the breeding colonies, the main objective of this tracking essay was to identify the oceanic regions where the birds forage during the non-breeding season. The non-breeding range of this bird was located south-east of Rapa Island, where fishery activities are limited. The conservation efforts for the Critically Endangered Rapa Shearwater should first focus on securing mammal-free sites for breeding colonies.

Introduction

The Rapa Shearwater *Puffinus myrtae* (Bourne 1959) has a tiny breeding population restricted to a few islets off Rapa Island (27°35'S, 144°20'W), and maybe Marotiri (85 km south-east of Rapa; Gaskin 2007), within the Austral Islands (Eastern Polynesia, South Pacific). There are very few at-sea observations, all off Rapa Island and Marotiri rocks, for example, in October–November 2019 and 2021 (Flood et al. 2021). In October 2021, H. Tanoi and S. Tanoi (personal communication) observed few individuals and only adults off Rapa, despite this being the typical fledging period for the species. An isolated report off Tahanea Island, Tuamotu, in March 2003 (VanderWerf et al. 2006) does not include a formal description of the observed bird to assess the identification (Flood and Zufelt 2021). Breeding at Rapa Island is seasonal, adults attend burrows from April to chick fledging in mid-November (Holyoak and Thibault 1984). If the population size was estimated at 250–360 pairs from surveys conducted in 1974 (Thibault and Varney 1991), recent estimates are dramatic, and the population today is severely reduced, with only 18 breeding pairs detected on Rapa Iti in 2019 (Thibault and Withers 2019), and only eight occupied burrows in July 2022 (Withers et al. 2023). This count was not exhaustive and some more pairs probably subsist on the islet or on other remote places on the island. The Rapa Shearwater is therefore listed as "Critically Endangered" (BirdLife International 2024) and its drastic decline is presumably related to the presence of introduced mammals, including chick predation by Pacific rats *Rattus exulans* (Withers et al. 2023), cat predation, and grazing of breeding slopes by goats (Thibault and Varney 1991).

Fisheries bycatch is also a potential issue affecting the species at sea, so that a better knowledge of the oceanic regions visited by the Rapa Shearwater is needed to test further this hypothesis (for other *Puffinus* species see Hatch et al. 2016; Uhlmann et al. 2003). In the context of an endemic tubenose species critically facing extinction, it was decided to track the year-round distribution of the species, to identify the oceanic regions where they exploit marine resources, then to assess the potential changes and challenges they might face there. Indeed, unravelling the at-sea distribution of such seabirds is crucial for their conservation. Bird remote tracking has been used first in large tubenoses (Jouventin and Weimerskirch 1990), but now the miniaturisation of embarked technologies allows the tracking of even the smallest species (e.g. storm-petrels; Militão et al. 2022). Given the critical status of Rapa Shearwater, and its small size and body mass, we decided to deploy light loggers fixed on a leg ring, expected to limit the long-term impact on birds (Kim et al. 2014), to collect light intensity data, and to reconstruct the distribution of the returning birds whose tags could be retrieved. We present here the analysis of data collected by a single light logger to document the at-sea distribution of an adult Rapa Shearwater during a complete non-breeding season.

Methods

Deploying tags

In August 2019, 10 light loggers (Intigeo W65-A9-SEA from Migrate Technology, see www.migratetech.co.uk) recording light intensity at five-minute intervals were deployed on adult shearwaters captured in their burrow on Rapa Iti. Tags were clamped on to a plastic ring placed on the bird's tibia, altogether weighing 1.2 g, representing less than 0.6% of a bird's body mass (average body mass mean ± SD = 210 ± 20 g for 15 adults weighed during the breeding season at Rapa). One tag was retrieved the following year and delivered useful data. The carrying adult bird was caught in a burrow on 31 August 2019, then recaptured in the open nearby the burrow of the previous year on 22 July 2020. Another individual wearing a logger was spotted on 1 August 2020 but could not be captured. DIREN (the local environmental authority) authorised the study (decree n°010978/MCE/ENV).

Light data analyses

We followed the guidelines of Lisovski et al. (2020) to perform the light data analyses. First, we used a threshold method to identify sunrise and sunset events with the R package "TwGeos" (Lisovski et al. 2015). In this step, we looked for errors on twilight events that we manually corrected when necessary. Days spent in the burrow (complete darkness during the day) were easily identified from visual inspection of raw light data and were used to delineate the non-breeding period (see Supplementary material Figures S1 and S2). We quantified the error distribution of sunrise/sunset times by using twilights from a known location (i.e. the location where the bird had been tagged: -27.61, -144.36). More specifically, we used the periods between 23 September and 5 October and between 1 March and 2 March as calibration periods. The two periods were chosen from visual inspection of the deviation of raw light data from the expected sunrise and sunset times at the deployment site (see Figure S1). we used the *getElevation* function from the "GeoLight" package to perform the calibration, following the guidelines of Lisovski et al. (2020).

Then, we used the group model of the package "SGAT" (Wotherspoon et al. 2016) to estimate geographical positions. The group model uses known stationary periods to estimate a single location from multiple twilight events. First, we used the *changelight* function from the package "Geolight" (Lisovski and Hahn 2012) to separate periods of residency from periods of movement, based on changes in sunrise and sunset times. The function uses the difference in day length to estimate movement periods given a change probability q. Due to the high sensitivity of *changelight* function to data quality, we ran the analyses with different parameters. We fixed a minimum stationary period of three days and tested a probability of change (q) of 0.7, 0.8, and 0.9. The identified stationary periods were then merged using the function *mergeSites* from the "Geolight" package (Lisovski and Hahn 2012). We fixed the first and last location as known locations (i.e. the deployment site) and first ran a modified Gamma model (relaxed assumptions) for 1,000 iterations to initiate the model, before running the model with final priors (three runs of 300 iterations). Finally, the model was run for 2,000 iterations to ensure convergence.

Fishing effort

We downloaded daily fishing effort for the period 2018–2020 from the global fishing watch database (Kroodsma et al. 2018). Each daily data file contains a list of cells at a 10th degree resolution with the fishing hours that occurred per day in each cell. We estimated the number of days of fishing activity over the period 2018–2020 in each cell of the grid when the fishing hours for a day was greater than 0.

Results

Breeding season and burrow attendance

Visualising light-intensity data collected by the logger allows the identification of the day spent in the dark, e.g. in a burrow, by the shearwater (see Figure S2). Days in a burrow are inferred by the absence of light in a 24-hour period. The bird stayed never more than two consecutive days in a burrow, so did not incubate an egg in 2020. The first day in a burrow occurred on 4 March 2020, then days spent in a burrow were: 12 and 13 March, 31 March, 19 April, 5 and 6 May, 17 and 18 May, 29 and 30 May, 8 and 9 June, 19 June, and 19 July. With 15 days spent in a burrow during five months (March–July), the bird visited the islet on average once every 10 days.

Non-breeding range

The regions of highest presence probability during the non-breeding season were concentrated between 140°W and 120°W in longitude, and 30°S and 45°S in latitude, so 1,000–2,000 km south-east of the breeding site on Rapa Island (Figure 1A). The at-sea occurrence also evolved during the non-breeding season, being concentrated around Rapa Island in October, and being the furthest south-east in January (Figure 1B). Three modelled paths over the non-breeding period estimated with different values of probability of change (q) are presented in Figure S3. The map of fishing activities in the region is presented in Figure S4.

Discussion

Having deployed 10 loggers on adult shearwaters visiting a breeding colony, one might have expected more than one logger to be retrieved. A second equipped bird was observed but could not be recaptured, resulting in a detection rate of 20%. This is low for a long-lived seabird but can be explained by the very low burrow occupancy since 2020 on Rapa Iti with no more than eight occupied burrows (Withers et al. 2023). Moreover, access to Rapa Island was difficult and reduced during the COVID pandemics, and access to Rapa Iti is constrained by meteorological conditions during the breeding season. Finally, the data collected by the retrieved logger attested that the returning adult did not breed in 2020, but attended the colony, with visits occurring every one to four weeks. Hence, the probability that a tagged bird and a scientist do meet on the islet should not be far from 20%. We therefore do not consider that tagging had a notable impact on the fate, survival or breeding capability of the birds. The non-breeding range reported here is therefore highly dependent on the single tracked individual, though we considered it was worth publishing the information, given the critical conservation status of the species. Observed results should however be confirmed by further tracking of a few individuals.

Tubenoses worldwide face a variety of threats, including historical and traditional harvest, introduced mammals, fisheries-related mortality, and disease (Dias et al. 2019). The monitoring on the few breeding sites frequented by the Rapa Shearwater at Rapa Island

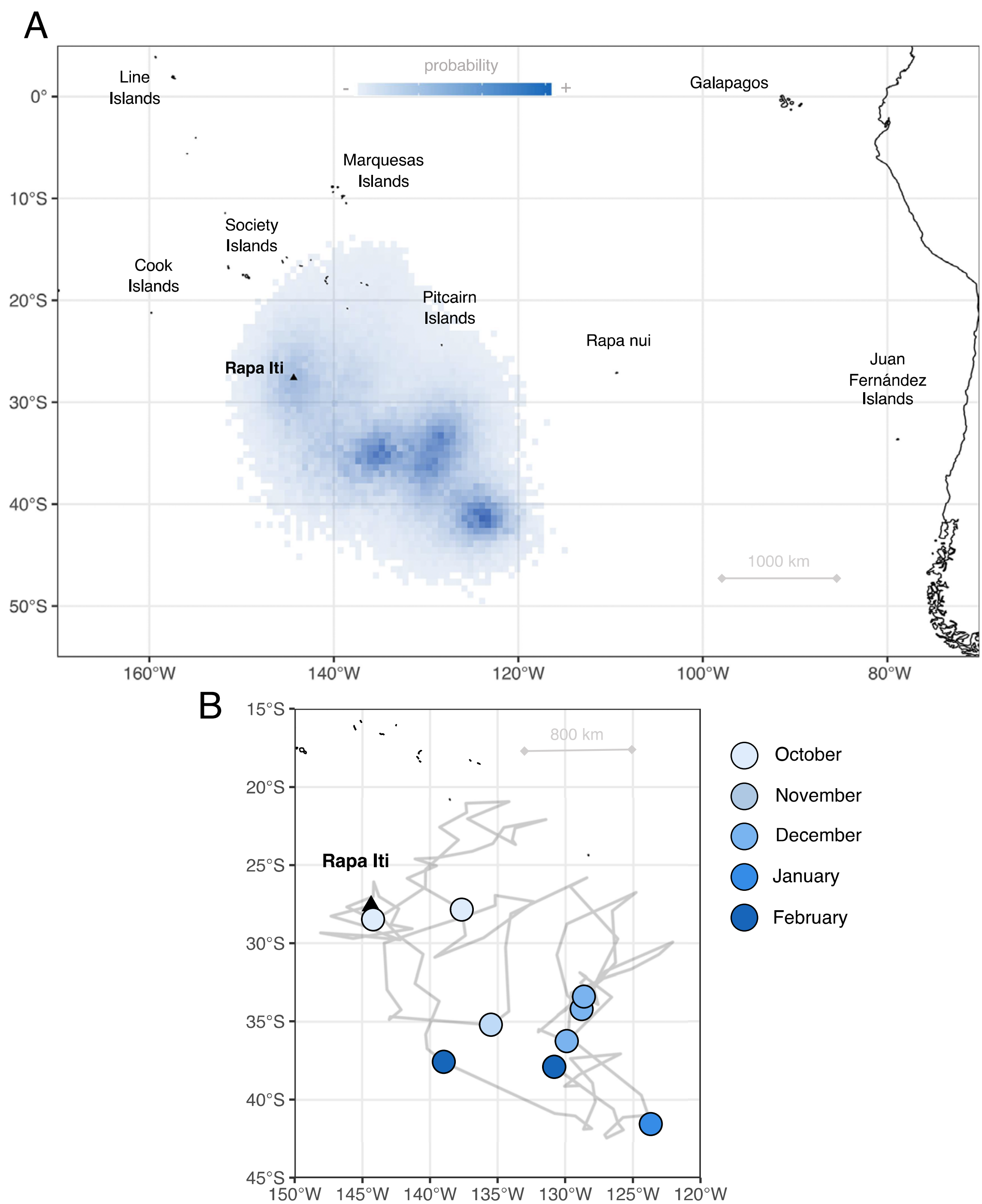

Figure 1. Non-breeding ranges of a tracked Rapa Shearwater *Puffinus myrtae* equipped on Rapa Iti. In (A), the blue colour represents the 50% probability distributions of location estimates derived from geolocator analysis using SGAT (the darker areas represent higher probability distribution). In (B), the grey line represents a possible modelled path of the bird outside the breeding season. The coloured dots represent the median position of stationary periods of at least three days estimated with the *changelight* function from the package "Geolight" (with q = 0.8, see Methods for details).

identified several threats impacting directly the breeding performance of the species: free-ranging goats were grazing on breeding islets, while Pacific rats were present with confirmed chick predation (Withers et al. 2023). However, the goats were removed between 2019 and 2021 and rat eradication was implemented in 2023 on the main breeding islet of Rapa Iti and Tauturou. Success of this operation is not yet known and will be checked mid-2025. The Polynesian Ornithological Society SOP Manu and BirdLife International also plan to remove rats from Karapoo Rrahi (another breeding site for the Rapa Shearwater). However, a more thorough feasibility plan with rope-climbing is needed before carrying out this project. A remaining important topic for fighting the imminent extinction of the species is to evaluate the risk faced at sea and linked to potential fisheries-related mortality, which was the objective of the present study.

Among petrels and shearwaters breeding in the South Pacific many have been tracked with light loggers. All tracking studies illustrated that these tubenoses move to predictable prey patches

https://doi.org/10.1017/S0959270924000182 Published online by Cambridge University Press

around physical oceanographic features such as shelf- and ice-edges and upwellings (Weimerskirch 2007), where humans also gather to exploit marine resources, fisheries being particularly active and a potential threat as bycatches. Sooty Shearwaters *Ardenna grisea* from New Zealand move to the northern hemisphere (Shaffer et al. 2006). In the temperate South Pacific, Gould's Petrels *Pterodroma leucoptera leucoptera* from Australia, *P. leucoptera caledonica* from New Caledonia, and Pycroft's Petrel *P. pycrofti* from New Zealand all disperse northwards to the equatorial Pacific (between 20°N and 20°S), from March to November (Rayner et al. 2016). Murphy's Petrels *Pterodroma ultima* from Henderson Island move to the North Pacific (mainly north of 40°N) during the non-breeding season (Clay et al. 2017). The Black-winged Petrel *Pterodroma nigripennis* is another summer-breeding gadfly petrel of the South Pacific moving to the northern hemisphere to winter (Rayner et al. 2023). On Rapa Island, it occupies the same burrows as Rapa Shearwater but during the austral summer. Westland Petrel *Procellaria westlandica* from New Zealand is the only tracked species to move eastwards towards the south Chilean waters (Landers et al. 2011). In this context, the south-eastwards move of the tracked Rapa Shearwater appears original, while the oceanic region exploited by this individual during the non-breeding season in not concerned by noticeable fishery activities. Further tracks are needed before considering that fisheries-related mortality is not a threat for the Critically Endangered Rapa Shearwater. Meanwhile, we advise that conservation efforts should first focus on securing mammal-free sites for breeding colonies.

Supplementary material. The supplementary material for this article can be found at http://doi.org/10.1017/S0959270924000182.

Acknowledgements. We are highly indebted to the local authorities and community on Rapa Island, including the tavana (mayor, Tuanainai Narii), the Tohitu (council of elders), the Tomite Rahi, and the environmental NGO Raumatariki. We thank BirdLife International Conservation Leadership Program and David and Lucille Packard, which funded the field work. We also thank Jacob González-Solís for sharing his experience on tag attachment to small *Puffinus.* We thank Dr Matt Rayner and Robert Flood for their review of an earlier version of the manuscript.

References

BirdLife International (2024). Species Factsheet: *Puffinus myrtae.* Available at https://datazone.birdlife.org/species/factsheet/rapa-shearwater-puffinus-myrtae (accessed 18 February 2024).

Bourne W.R.P. (1959). A new Little Shearwater from the Tubaui Islands: *Puffinus assimilis myrtae* subsp. nov. *Emu* **59**, 213–215.

Clay T.A., Phillips R.A., Manica A., Jackson H.A. and Brooke M. de L. (2017). Escaping the oligotrophic gyre? The year-round movements, foraging behaviour and habitat preferences of Murphy's petrels. *Marine Ecology Progress Series* **579**, 139–155. https://doi.org/10.3354/meps12244

Dias M.P., Martin R., Pearmain E.J., Burfield I.J., Small C., Phillips R.A. et al. (2019). Threats to seabirds: A global assessment. *Biological Conservation* **237**, 525–537. https://doi.org/10.1016/j.biocon.2019.06.033

Flood R.L. and Zufelt K. (2021). *Pelagic Observations, Gambier Islands to Tahiti via Austral Islands, October–November 2019, and Past Expeditions in East Polynesia.* Technical PSG Publication Number 3. Pacific Seabird Group. Available at https://pacificseabirdgroup.org/psg-publications/technical-publications/.

Flood R.L., Zufelt K., Bretagnolle V. and Shirihai H. (2021). 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*. *Bulletin of the British Ornithologists' Club* **141**, 387–411. https://doi.org/10.25226/bboc.v141i4.2021.a3

Gaskin C. (2007). Marotiri survey report. *Te Manu* **59**, 7–8.

Hatch J.M., Wiley D., Murray K.T. and Welch L. (2016). Integrating satellite-tagged seabird and fishery-dependent data: A case study of Great Shearwaters (*Puffinus gravis*) and the U.S. new England sink gillnet fishery. *Conservation Letters* **9**, 43–50.

Holyoak D. and Thibault J.-C. (1984). Contribution à l'étude des oiseaux de Polynésie orientale [Contribution to bird study in Eastern Polynesia]. *Mémoires du Muséum National d'Histoire Naturelle. Série A, Zoologie* 127, 1–209.

Jouventin P. and Weimerskirch H. (1990). Satellite tracking of Wandering albatrosses. *Nature* **343**, 746–748. https://doi.org/10.1038/343746a0

Kim Y., Priddel D., Carlile N., Merrick J.R. and Harcourt R. (2014). Do tracking tags impede breeding performance in the threatened Gould's Petrel *Pterodroma leucoptera*? *Marine Ornithology* **42**, 63–68.

Kroodsma D.A., Mayorga J., Hochberg T., Miller N.A., Boerder K., Ferretti F. et al. (2018). Tracking the global footprint of fisheries. *Science* **359**, 904–908.

Landers T.J., Rayner M.J., Phillips R.A. and Hauber M.E. (2011). Dynamics of seasonal movements by a trans-Pacific migrant, the Westland Petrel. *The Condor* **113**, 71–79.

Lisovski S., Bauer S., Briedis M., Davidson S.C., Dhanjal-Adams K.L., Hallworth M.T. et al. (2020). Light-level geolocator analyses: A user's guide. *Journal of Animal Ecology* **89**, 221–236. https://doi.org/10.1111/1365-2656.13036

Lisovski S. and Hahn S. (2012). GeoLight – processing and analysing light-based geolocator data in R. *Methods in Ecology and Evolution* **3**, 1055–1059. https://doi.org/10.1111/j.2041-210X.2012.00248.x

Lisovski S., Sumner M.D. and Wotherspoon S.J. (2015). R-package TwGeos: Basic Data Processing for Light-based Geolocation Archival Tags. Available at https://github.com/slisovski/TwGeos.

Militão T., Sanz-Aguilar A., Rotger A. and Ramos R. (2022). Non-breeding distribution and at-sea activity patterns of the smallest European seabird, the European Storm Petrel (*Hydrobates pelagicus*). *Ibis* **164**, 1160–1179. https://doi.org/10.1111/ibi.13068

Rayner M.J., Carlile N., Priddel D., Bretagnolle V., Miller M.G.R., Phillips R.A. et al. (2016). Niche partitioning by three Pterodroma petrel species during non-breeding in the equatorial Pacific Ocean. *Marine Ecology Progress Series* **549**, 217–229. https://doi.org/10.3354/meps11707

Rayner M.J., Gaskin C.P. and Taylor G.A. (2023). Seasonal movements, foraging activity, and breeding biology of black-winged petrel (*Pterodroma nigripennis*) from three New Zealand colonies. *Notornis* **70**, 111–123.

Shaffer S.A., Tremblay Y., Weimerskirch H., Scott D., Thompson D.R. et al. (2006). Migratory shearwaters integrate oceanic resources across the Pacific Ocean in an endless summer. *Proceedings of the National Academy of Sciences – PNAS* **103**, 12799–12802. https://doi.org/10.1073/pnas.0603715103

Thibault J.-C. and Varney A. (1991). Breeding seabirds of Rapa (Polynesia): numbers and changes during the 20th century. *Bulletin of the British Ornithologists' Club* **111**, 70–77.

Thibault J.-C. and Withers T. (2019). Seabirds of Rapa, Austral Is., French Polynesia: breeding 2019. Unpubl. rep. *Société d'Ornithologie de Polynésie & BirdLife International.*

Uhlmann S. (2003). *Fisheries Bycatch Mortalities of Sooty Shearwaters (Puffinus griseus) and Short-tailed Shearwaters (P. tenuirostris)*. DOC Science Internal Series 92. Wellington: Department of Conservation.

VanderWerf E.A., Pierce R.J., Gill V.A., Wragg G., Raust P. and Tibbitts L. (2006). Pelagic seabird surveys in the Tuamotu and Gambier archipelagos, French Polynesia. *Marine Ornithology* **34**, 65–70.

Weimerskirch H. (2007). Are seabirds foraging for unpredictable resources? *Deep Sea Research II: Topical Studies in Oceanography* **54**, 211−223.

Withers A.T.S., Laitame T. and Tehau M. (2023). *Testing Conservation and Habitat Restoration Methods to Preserve Rapa's Avifauna (French Polynesia).* Conservation Leadership Programme: Final Report. Available at https://www.conservationleadershipprogramme.org/project/testing-habitat-restoration-rapa/.

Wotherspoon S., Sumner M. and Lisovski S. (2016). R Package SGAT: Solar/satellite Geolocation for Animal Tracking. Available at https://github.com/SWotherspoon/SGAT.