POPULATION STATUS OF THE KERMADEC PETREL *PTERODROMA NEGLECTA JUANA* AT SAN AMBROSIO ISLAND, CHILE

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ABSTRACT

MARÍN, M., GONZÁLEZ, R. & TRUCCO, S. 2020. Population status of the Kermadec Petrel (*Pterodroma neglecta juana*) at San Ambrosio Island, Chile. *Marine Ornithology* 48: 209–214.

We visited San Ambrosio Island off northern Chile (26°21′S, 079°47′W) on 10–12 December 2019. We found a large population of Kermadec Petrel *Pterodroma neglecta juana* that appeared to be healthy. In the area that we could survey, we estimated at least 22 686 breeding pairs, which is an underestimate of the entire population as we could not access some steep areas. Introduced mammals, which have since been eradicated, caused a loss of island vegetation that might be a drawback for this population, as shading from the sun appears to be important for nest-site selection. Egg-laying started by early December. We assessed 223 birds with respect to coloration: most birds were intermediate phase (65%) and the rest were either very dark (23%) or very pale (12%). We found skeletal remains of goats and rabbits on the island but no living mammals, although a single goat may still be alive. In the context of an estimated world population of ~100 000 pairs of Kermadec Petrel, the San Ambrosio Island population contributes significantly.

Key words: Kermadec Petrel, *Pterodroma neglecta juana*, population, breeding seasonality, introduced mammals, eastern South Pacific, Chile

The Kermadec Petrel *Pterodroma neglecta* is a dichromatic species that has a trans-Pacific distribution, breeding in the subtropics between 25°S and 35°S from Lord Howe Island in the Tasman Sea to the Juan Fernandez Archipelago in the eastern South Pacific (Marchant & Higgins 1990). A disjunct population was recently found on Round Island, Mauritius (Indian Ocean; Brooke *et al.* 2000). Normally the species is divided among two taxa: *P. n. neglecta* on the western side of the Pacific Ocean and a *P. n. juana* on the eastern side. The eastern subspecies breeds on Robinson Crusoe and Santa Clara on the Juan Fernandez Archipelago (main islands: Robinson Crusoe, Santa Clara, Alejandro Selkirk) and on San Ambrosio Island on the Islas Desventuradas Archipelago (main islands: San Félix, San Ambrosio, González) off Chile (Murphy 1936, Murphy & Pennoyer 1952, Marchant & Higgins 1990).

Most data from the eastern South Pacific (Chilean) population are somewhat sketchy and are from the Juan Fernandez group, where several observers consider Kermadec Petrel numbers to be small. Schalow (1898), although he does not mention numbers, indicates that it is common to see them flying over the steep lava slopes [at Robinson Crusoe Island]. Further, he mentioned that breeding occurred in December and January, with fat nestlings out of the nest in March. Lönnberg (1921) based his comments on Käre Bäckström's field notes from 1917, which were made at Robinson Crusoe Island and indicated that the species consisted of a few hundred breeding pairs. He added that the Kermadec Petrel bred exclusively on the cliffs below Centinela Hill and that the breeding season began at the end of January through February. Murphy (1936) indicated that the species nests at Santa Clara and Robinson Crusoe islands and commented on the Bäckström notes. He surmised that the reduced population at the Juan Fernandez Archipelago was probably anthropogenic. Somehow, contrary to those comments, Goodall *et al.* (1951) reported that these birds were common and locally well-known, called "Fardela del Día" because they can be seen at any time of day flying over the island [based on R.A. Philippi's notes from a February 1928 visit to Robinson Crusoe Island]. Later, Goodall *et al.* (1957) mentioned that the species was very abundant, based on a W.R. Millie account from a visit in October 1955. At that time, Millie found Kermadec Petrels in large numbers at Punta Salinas (Robinson Crusoe Island) but no nests. When Jehl (1973) visited the Juan Fernandez Archipelago in June 1970, he saw only two birds and they were of the dark phase. Schlatter (1984, 1987) mentioned that the population was apparently decreasing in Juan Fernandez but added no new information to that already published. During a visit to Robinson Crusoe and Santa Clara islands in December 1985 to January 1986, Brooke (1987) observed these petrels in three areas among the cliffs: below Centinela Hill, between Cumberland Bay and Puerto Ingles, and below Quebrada Juanango. He guessed the population of Santa Clara and Robinson Crusoe islands to be no more 200 breeding pairs. More recently, P. Hodum (pers. comm. in May 2020) indicated that the species also nested at El Verdugo and Juanango islets at Robinson Crusoe Island and that the population for the Juan Fernandez Archipelago is not more than 100–200 breeding pairs. Thus, for the last 100 years or so, the population numbers of *P. n. juana* have been reported as about the same. Judging from published and unpublished information, egg-laying in the Juan Fernandez Archipelago starts in December through early February, and fledglings are present from March through early May. Johnson (1965), based on an unpublished report by M. Moynihan, reported that Kermadec Petrels also nested on Rapa Nui (Easter Island, Chile). It is a small population with unknown number of breeding pairs. There has been some confusion among the locals about the subspecies identity of the Rapa Nui population,

but it has probably correctly been attributed to the nominate race *P. n. neglecta* by Marchant & Higgins 1990, del Hoyo *et al.* 1992, and Dickinson & Remsen 2013; this will be confirmed in a future study.

Regarding the San Ambrosio Island population (Islas Desventuradas Archipelago), information is even more scanty, mainly because of the restrictions and difficulty in accessing the island. Murphy (1936) mentioned Chapin's notes, which were written when the yacht *Zaca* of the American Museum of Natural History expedition passed by on 18 February 1935. No one landed, but Chapin mentioned that hundreds of birds were seen circling and engaging in aerial displays on the summits of San Ambrosio Island from late afternoon until dusk. This observation led Murphy to infer that they were breeding on San Ambrosio Island, but no nests were found by that expedition. Millie (1963) indicated that the Kermadec Petrel was common at San Ambrosio Island in October 1962 and that they nest at the summit of the island under the shrubs in December. (Nesting information was probably derived from the lobster fishermen that visited the island group; Millie never made it to the summit and only landed at Caleta Las Moscas.) Bahamonde (1965, 1987) visited the islands in August–September 1960 and noted the presence of Kermadec Petrel only at San Ambrosio Island. When Jehl (1973) visited San Ambrosio and San Félix islands in June 1970, he observed only a single bird in the vicinity. He also mentioned that he landed, but never made it to the summit. Schlatter (1984) indicated there was only a single breeding pair for the Islas Desventuradas Archipelago. More recently, Aguirre *et al.* (2009) are probably the first ornithologically inclined observers that made it to the summit of San Ambrosio Island. Their party landed for seven hours on 15 December 2001 and six hours on 20 March 2003. Furthermore, they passed by San Ambrosio Island in June 2001 and landed on San Félix, but they did not observe the species on either island on that date. Nests were found on flat areas in cavities among partially exposed rocks of different sizes (Aguirre *et al.* 2009). Their observations represented the first real breeding confirmation of the species on the archipelago. During their December 2001 visit, they estimated 150 breeding pairs and observed adults engaged in aerial displays during daylight hours. A botanical group who visited the island in mid to late April 2019 found well-grown nestlings, providing a further clue to the species' breeding seasonality.

Our visit to San Ambrosio Island

As part of a bird survey of the Islas Desventuradas Archipelago, we visited San Ambrosio Island (also known as Ambrose Island) on 10–12 December 2019. The island is located at 26°20′S, 079°54′W, and it has a surface ~203 ha (2.03 km^2; not considering slope surfaces of the numerous ravines) and a maximum elevation of 478 m. The island has an ellipsoidal shape, and it is ~2.8 km in length with a maximum width of ~1 km (estimated using Google Earth © 2020). It is part of the Islas Desventuradas Archipelago, which includes San Ambrosio, San Félix, and González as main islands, along with a few rocky outcrops, with the most remarkable being the Peterborough Cathedral. San Ambrosio Island is about 825 km north of Robinson Crusoe Island (Juan Fernandez Archipelago) and 898 km west of the port of Chañaral in Chile. Positions and distances were taken from marine charts: British Admiralty chart 4608 and Servicio Hidrográfico y Oceanográfico de la Armada (Chile) charts 510, 2410, and 2411.

San Ambrosio Island is a volcanic island, having an upper plateau but otherwise rising directly from the sea 200–300 m (Fig. 1). Thus, it is exceedingly difficult to access the top plateau, other than at two places on the northern coast (Fig. 1A). The semi-flat terrain on top has a gentle slope and is dissected across the island from south to north by several ravines. The southern end has the highest altitude, where the ravines are shallower with gentler slopes (Fig. 1B). From the south to the north, the ravines descend toward the sea at different degrees of slope; closer to the coast toward the cliff edge in some places, they might form deep gorges of 50 m or more with slopes of ≥ 50°. Lacking water, the higher elevations in the south and the extreme southwestern part of the of island are covered by what appears to be seasonal vegetation; to the western side, sparse woody vegetation was present. At the time of our visit in December, most vegetation was dry. The island had abundant vegetation ~40–50 years ago (e.g., Kuschel 1963), but now only stumps and woody debris remains from what was once a forested area. The loss of herbaceous vegetation occurred in the 1970s, when rabbits and then goats were introduced by lobster fishermen in 1971 and 1976, respectively (A. Recabarren, pers. comm.). By March 2003, only a few patches of live herbaceous plants were present, along with

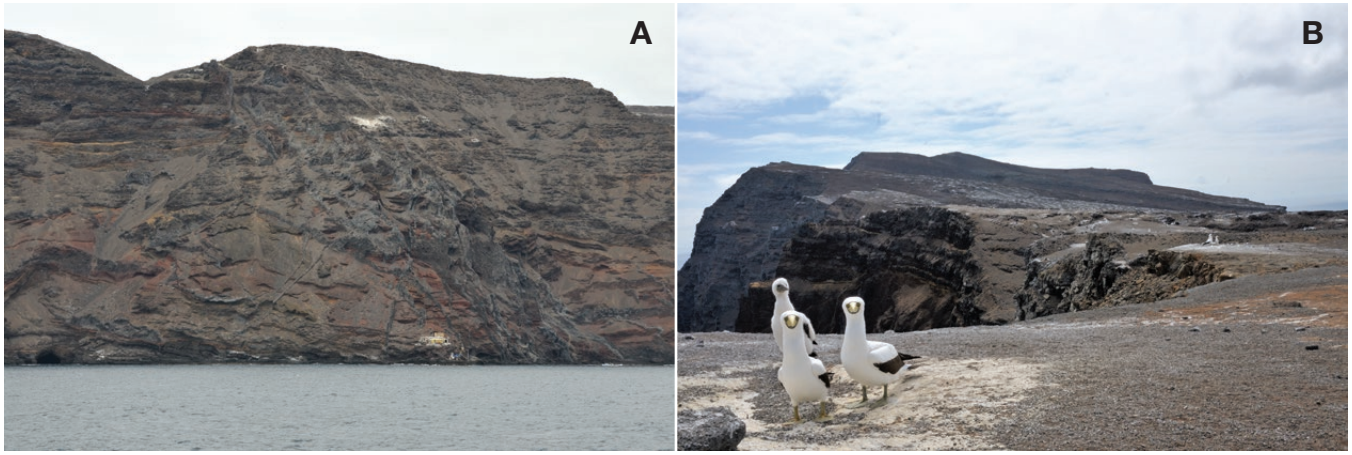

Fig. 1. San Ambrosio Island. A) Caleta Covadonga at Punta Potalas, one of the access points to the peak. On the lower right, the fishermen's enclave can be seen. B) The upper plateau on the south side of the island, looking from the east to the west. In the foreground are Masked Boobies *Sula dactylatra* and in the background is the highest point of the island. (Photos by M. Marín.)

woody vegetation at the bottom of ravines (J. Aguirre pers. comm., Aguirre *et al.* 2009).

Aguirre *et al.* (2009 and pers. comm.) observed 6–8 goats but no live rabbits at San Ambrosio Island in March 2003. Sometime after 2003, most of the goats were shot, either by lobster fishermen or navy personnel, leaving two females; we found several military-grade high-caliber shell casings (of restricted use by civilians in Chile) on different sectors of the island. In September 2018, L. Mekis (pers. comm.) visited the island and saw no signs of rabbits or goats. However, in April 2019, he found two female goats. A couple of months before our visit of December 2019, lobster fishermen shot one of the goats, leaving just a single female present on the island. The rabbits disappeared before 2003, most likely due to a lack of freshwater and the consumption of the remaining edible plants. We saw no sign of the rabbits in 2019, despite our search for scats, tracks, cavities, etc., though we did find skeletal remains of both rabbits and goats. According to the fishermen, the single goat is easily frightened, and it hides on the cliffs at the first sign of human presence. However, if it was one of the goats observed in 2003 by Aguirre *et al.* (2009), it should not have many years left of its natural life span. In some areas, the vegetation appears to be returning and will probably take many years to become re-established.

Estimated population size

During our two nights and three days visiting the island, we traversed about 80% of the island and scanned the remainder from high points. On the first day, we realized that the petrel population was substantial, and we decided to undertake a rough estimate of its population size. We randomly established 10 plots on different parts of the island: four were on the eastern end of the island, three were in the middle, and three were on or near the highest point toward the western end. The latter was where the highest nest density occurred, under dry vegetation. In one 50-m^2 plot, we found 14 active nests, some as close as 30 cm to one another (e.g., Fig. 2B). The nests were mostly a simple scrape, some containing dry vegetation, and were located next to rocks or slope ledges, on cavities or cavity edges, under old and dry bush, or under dry plants (see also Figs. 2, 3). None of the nests were located on the flat, fully exposed areas where there are no large rocks or vegetation for shading. It seems that the petrels sought some sort of shade.

The plots were all the same width but of different lengths, ranging from 50 m^2 to 1 200 m^2 (Table 1) depending on the terrain, which ranged from undulated to slopes with gradients up to ~40°. We counted all nests in each plot and calculated a nest

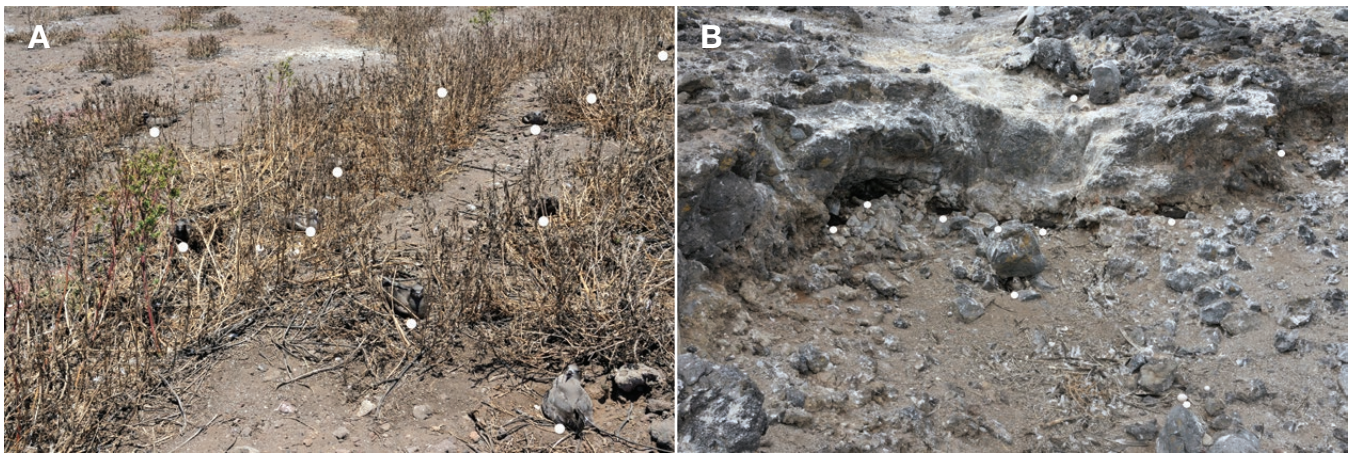

Fig. 2. Examples of nest concentrations of Kermadec Petrels in different microhabitats. A) White dots indicate 11 nests that are hidden among the dry shrubs in a semi-flat area on the top of the island. B) Looking down a small ravine for maximize photographic coverage, 10 nests (white dots) on the slope are located mostly at the base of the small ledge. In both cases, the birds appear to be seeking shade. (Photos by M. Marín.)

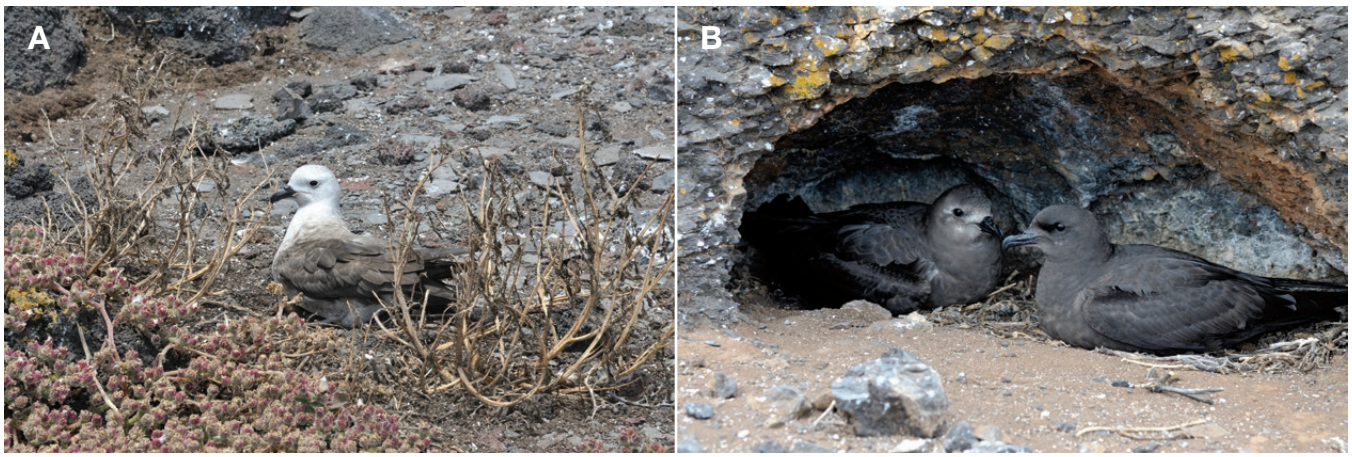

Fig. 3. The different color phases of Kermadec Petrels. A) Light phase. B) A dark phase (right) and an intermediate phase (left) on separate nests. Notice the proximity of the two nests; we found many similar cases. (Photos by M. Marín.)

density for each plot. In the five plots of equal size, the average nest density was 0.160 nest/m^2, and the average of all 10 plots was 0.166 nest/m^2. We extrapolated the average nest density of all plots to the species' minimum breeding surface area, which we estimated to be ~144.5 ha (1.445 km^2; this did not include the steep slopes). We did not observe any bird activity over the cliff areas, as it was concentrated over the plateau (e.g., nests, aerial displays, etc.). Similarly, the same was observed by Chapin (in Murphy 1936), Millie (1963), and Aguirre *et al.* (2009). From afternoon until darkness, large numbers of petrels circled above, particularly near and over the summit, despite it being the main nesting habitat on Robinson Crusoe Island (see above). We observed neither nests nor bird activity along the cliff edges (although these were not fully searched, as we did not rappel the 300-m cliff faces).

We calculated an average nest density of 166 ± 9 nests/ha (see also Fig. 2), and from that we estimated 23 987 breeding pairs (range: 22 686–25 287). Because we did not include the steep slopes, this must be considered an underestimate. Brooke (2004) estimated a world breeding population of 75 000–100 000 pairs and mentioned that the main breeding areas for the species were in the South Pacific on the Kermadec Islands (~10 000 pairs) and on the Pitcairn islands (~30 000 pairs). Therefore, the San Ambrosio Island population is significant. In addition, Aguirre *et al.* (2009) mentioned the species as breeding (unknown number of pairs) at San Félix Island (Islas Desventuradas Archipelago), but no other information was provided. Navy personnel from the base and lobster fishermen also mentioned occurrence at San Félix and at Islote González. However, it is not certain whether they breed on the other islands and rocks of the Desventuradas group. Doing so is likely, but in smaller numbers. In summary, the likely population size must far exceed previous estimations.

TABLE 1
Plot sizes, nest density, microhabitat, and area of the island where plots were made to assess Kermadec Petrels habitat on San Ambrosio Island

Plot size m^2	Nests/m^2	Microhabitat	Location on the island
50	0.28	Under dry plants	Western
50	0.18	Rocky slope	Central
100	0.06	Rocky slope	Eastern
100	0.12	Rocky slope	Eastern
100	0.06	Rocky slope	Eastern
100	0.18	Under dry plants	Central
100	0.38	Under dry plants	Western
200	0.15	Rocky slope	Central
200	0.12	Rocky slope	Eastern
1 200	0.13	Under dry plants	Western

Color variation

Mathews (1935) described *P. n. juana* using a specimen from the series collected by K. Bäckström on Robinson Crusoe Island, i.e., the very same series reported by Lönnberg (1921). Mathews (1935) mentions that this taxon differs from the nominate form by being larger and "being darker and in never having the light phase". The latter statement was dismissed by Murphy (1936: pg. 657, plate 40), who published two photos taken by R. Beck of an extreme light phase and a dark phase on nests, both at Robinson Crusoe Island. Later Murphy & Pennoyer (1952) corrected Mathews, concluding that the two geographic taxa can be separated based on measurements rather than on plumage. Murphy & Pennoyer (1952: pg. 27) published a table with numbers of light, intermediate, and dark-colored birds, having examined 249 individuals from the western Pacific, from Ducie Island to Lord Howe Island. They found 35% to be light, 31% to be intermediate, and 33% to be dark. In the same table, Murphy & Pennoyer (1952) reported 100 individuals, from both the Juan Fernandez (n = 87) and the Islas Desventuradas (n = 12) archipelagos, reporting 3% as light, 54% as intermediate, and 43% as dark. On San Ambrosio Island, we took notes on the color phase of 223 birds.

We defined the color phases as A) dark: no pale markings on face or body; B) intermediate: having some pale markings either facial, forehead, or on body; and C) light: having white or whitish head, upper back, chest, and belly (see also Fig. 3). We found 51 birds (23%) to be dark, 145 (65%) to be intermediate, and 27 (12%) to be light. As far as we can assess, mating between birds of different color phases seems to be random, with little, if any, assortative mating. A larger sample might give a different assessment on the proportion of the different color phases. Indeed, in the eastern population, there are more full whites than was previously assessed. Furthermore, all dark and intermediate birds that we looked at had dark legs and feet, while only some of the light individuals had bicolor feet; the distal parts black and proximal parts were paler (toward pinkish), but not as strikingly pale as in other *Pterodroma* species, e.g., Phoenix Petrel *P. alba*.

Breeding phenology

To determine the breeding phenology of the Kermadec Petrel at San Ambrosio Island, we used all information available to us, including published data, and unpublished data, and museum specimens. Our 10–12 December visit was at the onset of the breeding season. A large percentage of pairs were on eggs, with many pairs exhibiting aerial displays; some pairs were just sitting on the nests without eggs. On the other hand, Aguirre *et al.* (2009) found eggs and recently hatched young on 15 December, indicating that some eggs were laid by mid-October. On our visit, we found no young, though we visited on similar dates. There appears therefore to be a slight shift in breeding phenology among years. L. Mekis (pers. comm.) found a few adult birds by mid-September but no eggs. In mid to late March, Aguirre *et al.* (2009, J. Aguirre pers. comm.) found some nestlings but mostly well-grown chicks. In mid-April, there were only well-grown nestlings (L. Mekis pers. comm.). However, as mentioned by several authors, the timing of the breeding season on Robinson Crusoe Island is about the same as on San Ambrosio Island (see above). Unless there are annual shifts at San Ambrosio Island, eggs can be found from December onwards, probably until early February; nestlings start to fledge in April/May. The eastern subspecies (*P. n. juana*) seems to have a more synchronous breeding

season with a post-breeding movement, while *P. n. neglecta*, at least in some areas, seems to breed throughout the year with some peaks, for example, on the Kermadec group (Veitch & Harper 1998) and on Easter Island (Marín & Caceres 2010).

Judging by previous reports, the Kermadec Petrel has a post-breeding movement and vacates nesting areas, as the species is very rare or not present in either archipelago during winter (e.g., Jehl 1973, Aguirre *et al.* 2009). Departure from San Ambrosio Island starts in March/April, and birds begin to return by September/October; the same should occur at Robinson Crusoe Island. Most individuals might move north, but to an unknown degree. At sea, this species is never numerous and does not seems to flock in large numbers. However, individuals that might belong to this population have been observed along the edge of the eastern South Pacific. For example, Loomis (1918) observed birds in October between 07°N and 15°N, with two birds collected west of Central America: the first at 14°N, 107°W and the second at 15°N, 110°W. During 18 scientific cruises in the spring and autumn, Spear & Ainley (1993) observed a few hundred birds in the warmer waters of the tropical eastern Pacific, between 25°S and 25°N and between 110°W and 155°W. One of us (MM) has observed the species in good numbers (1–10 individuals per morning) ~180 km off the coast of southern Peru and northern Chile in March/April.

Concluding thoughts

The Kermadec Petrel is a surface breeder with extremely exposed nests; individuals have no fear of humans or other mammals. Murphy (1936) pointed out that the breeding population at Robinson Crusoe Island was once numerous and that nesting on ledges and inaccessible cliffs [which, as far as we know, did not occur in San Ambrosio Island] represents an adaptation by the remnants of a population that has been heavily disturbed by humans and their animals (e.g., domestic cats/dogs; Brown-nosed Coati *Nasua nasua*, which was introduced in the 1930s for pest control). San Ambrosio Island currently does not have such large disturbances, and mammals have been eradicated, except for one female goat that should not have many years left, given its life expectancy of around 10–12 years. Otherwise, the population of Kermadec Petrels on San Ambrosio Island seems to be in good health, as we found neither egg destruction nor bird mortality. The single predator species that we observed was the American Kestrel *Falco sparverius* with no more than 12 breeding pairs. American Kestrels might take some petrel nestlings, particularly at their early stages. The depletion of vegetation by the introduced mammals might have affected petrel reproduction, as all birds were observed to seek shade and the highest nest density was under dry vegetation. Given that San Ambrosio Island might now have the largest Kermadec Petrel breeding population in the world, future effort to restore the vegetation should be made.

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