Bird Conservation International (2020), page 1 of 24. © The Author(s), 2020. Published by Cambridge University Press on behalf of BirdLife International
doi:10.1017/S0959270920000428

Distribution, abundance, and on-land threats to Cabo Verde seabirds

GILSON SEMEDO[1], VITOR H. PAIVA[1*], TERESA MILITÃO[2], ISABEL RODRIGUES[3], HERCULANO A. DINIS[4], JORGE PEREIRA[1], DIANA MATOS[1], FILIPE R. CEIA[1], NATHALIE M. ALMEIDA[1,3], PEDRO GERALDES[5], SARAH SALDANHA[2], NADITO BARBOSA[4], MARCOS HERNÁNDEZ-MONTERO[6], CAROLINO FERNANDES[4], JACOB GONZÁLEZ-SÓLIS[2] and JAIME A. RAMOS[1]

[1]*University of Coimbra, MARE – Marine and Environmental Sciences Centre, Department of Life Sciences, Calçada Martim de Freitas, 3004-517 Coimbra, Portugal.*
[2]*Institut de Recerca de la Biodiversitat (IRBio) i Departament de Biologia Evolutiva, Ecologia i Ciències Ambientals, Universitat de Barcelona, Av. Diagonal 643, Barcelona 08028, Spain.*
[3]*Biosfera Cabo Verde, Rua de Moçambique 28, Mindelo, caixa postal 233, São Vicente, Cabo Verde.*
[4]*Associação Projecto Vitó, Xaguate, S. Filipe, Fogo, Cabo Verde.*
[5]*SPEA - Sociedade Portuguesa para o Estudo das Aves, Av. Columbano Bordalo Pinheiro, 87, 3º andar, 1070-062 Lisboa, Portugal.*
[6]*Associação Projeto Biodiversidade, Santa Maria, Ilha do Sal, Cabo Verde.*

**Author for correspondence; email: vitorpaiva@ci.uc.pt*

(Received 21 November 2019; revision accepted 30 June 2020)

Summary

Pelagic seabird populations have declined strongly worldwide. In the North Atlantic there was a huge reduction in seabird populations following the European colonization of the Azores, Madeira and Canary archipelagos but information on seabird status and distribution for the subtropical region of Cabo Verde is scarce, unavailable or dispersed in grey literature. We compiled and compared the historical and current distribution of all seabird species breeding in the Cabo Verde archipelago, updated their relative abundance, investigated their inland habitat preferences, and reviewed their threats. Currently, the breeding seabird community in Cabo Verde is composed of Bulwer's Petrel *Bulweria bulwerii*, White-faced Storm-petrel *Pelagodroma marina aedesorum*, Cape Verde Shearwater *Calonectris edwardsii*, Cape Verde Storm-petrel *Hydrobates jabejabe*, Cape Verde Petrel *Pterodroma feae*, Boyd's Shearwater *Puffinus lherminieri boydi*, Brown Booby *Sula leucogaster*, and Red-billed Tropicbird *Phaethon aethereus*. One breeding species is currently extinct, the Magnificent Frigatebird *Fregata magnificens*. The relative abundance of Cape Verde Shearwater, Boyd's Shearwater, Cape Verde Petrel, and Cape Verde Storm-petrel was determined from counts of their nocturnal calls in Santo Antão, São Vicente, Santa Luzia, Branco, Raso and São Nicolau. Cape Verde Petrel occurred only on mountainous islands (Santo Antão, São Nicolau, Santiago, and Fogo) from mid-to high elevations. Larger species such as the Cape Verde Shearwater and Boyd's Shearwater exhibited a wider distribution in the archipelago, occurring close to the coastline but at lower densities on populated islands. Small procellariforms such as the Cape Verde Storm-petrel occurred at high densities only on rat-free islets and in steep areas of main islands where introduced cats and rats are unlikely to occur. The main threats to seabird populations in Cabo

Verde range from predation by introduced predators, habitat alteration or destruction, and some residual human persecution.

Keywords: historical records of seabird occurrence, relative abundance, habitat modelling, nocturnal hearings

Introduction

Human activities such as habitat destruction and alteration, introduction of invasive species, overfishing and pollution are major threats to marine ecosystems, changing species abundance and distribution, and the structure, function and resilience of ecosystems (Doherty *et al.* 2016, Xu *et al.* 2016, Millán 2018). Biodiversity loss is particularly high for insular ecosystems because island populations tend to be small, present a high degree of endemism due to geographical isolation and consequently low level of resilience to introduced invasive species and the impact of climate change (e.g. Manne *et al.* 1999, Brooke *et al.* 2017). The marked decline in many seabird populations is an indicator of long-term and large-scale changes in insular, coastal, and offshore marine ecosystems (Paleczny *et al.* 2015). Pelagic seabird species are the group of birds showing the largest decline worldwide, with by-catch and predation by invasive species the most harmful threats at-sea and on-land, respectively (Anderson *et al.* 2011, Croxall *et al.* 2012, Dias *et al.* 2019).

At their breeding sites many seabird populations may face high levels of egg, chick and adult predation by introduced invasive species such as rats *Rattus* spp. mice *Mus musculus*, and cats *Felis catus* (Jones *et al.* 2008, Sarmento *et al.* 2014, Jones *et al.* 2019). Other introduced mammals such as rabbits *Oryctolagus cuniculus* and goats *Capra hircus* may also cause the loss of seabird breeding habitats (Jones *et al.* 2008). Globally, predation by introduced mammals is the leading cause of decline in eight species of Procellariidae, classified as 'Critically Endangered' by IUCN on islands around the world: Fiji, Reunion, Jamaica, Chatham, Galapagos, Balearics and Melanesia (Le Corre 2008). Similar cases of predation by introduced mammals are reported in the north-central islands of Chile (Simeone *et al.* 2003), the Galapagos Archipelago (Riofrío-Lazo and Páez-Rosas 2015), Guadalupe island, the Pacific Ocean and Socorro island (Nogales *et al.* 2013). Other inland threats, such as human capture and trampling of nests (e.g. Cima and Laje Branca islets), the destruction of shore areas to build human infrastructure (hotels, ports), habitat fragmentation and light pollution also affect seabird populations (Hazevoet 1995, Ratcliffe *et al.* 2000, Paleczny *et al.* 2015). Seabird populations may also be threatened in their coastal and pelagic foraging areas, including entanglement in fishing gear, overfishing, climate change and/or marine pollution (Furness and Taske 2000).

In the North Atlantic there was a huge reduction in seabird populations following the European colonization of the Azores (Monteiro *et al.* 1996), Madeira, Canary, and Cabo Verde (Vasconcelos *et al.* 2015, Saavedra *et al.* 2018) archipelagos. Currently, introduction of exotic mammals is one of the main factors explaining the distribution and abundance of small Procellariiformes in these archipelagos, such as Bulwer's Petrel *Bulweria bulwerii* and Madeiran Storm-petrel *Hydrobates castro*, which breed only on islets or steep inaccessible cliffs on main islands that are free from rats (Monteiro *et al.* 1999). In relation to the subtropical region of Cabo Verde, information on the status and distribution of seabird species is scarce, unavailable, or dispersed in grey literature. The main work carried out to date in Cabo Verde reports some information on the occurrence, breeding phenology, and threats to seabird species (Hazevoet 1994). Recently, one species, Cape Verde Petrel *Pterodroma feae*, was characterized in terms of population size and threats, though only in a single breeding site (Militão *et al.* 2017). However, there is still a great lack of information on the status, distribution, abundance, and threats to breeding seabird populations throughout the archipelago.

In the Azores, a historical review of seabird distribution together with survey and censuses directed at the various species made it possible to infer a strong reduction in seabird populations in the archipelago following colonization of the islands by humans (Monteiro *et al.* 1996, 1999). Similarly, Cabo Verde seabirds have been exploited as a food resource for centuries, leading to a

decline in their numbers (Murphy 1924, Hazevoet 1994, 1996). Preliminary observations made in Cabo Verde by Rendall and Pile (2007), Oliveira *et al.* (2013) and Vasconcelos *et al.* (2015) show that as with species nesting in the northernmost archipelagos (Azores, Canary and Madeira), smaller seabird species are largely confined to islets without exotic predators such as rats and cats. Larger seabird species should have a wider distribution in the archipelago, similar to what occurs in the Azores and Madeira (Romano *et al.* 2010), where Cory's Shearwater *Calonectris borealis*, a medium-size seabird, breeds along the cliffs of most of the islands (Monteiro *et al.* 1996).

Three orders of seabirds are found in Cabo Verde: Procelariiformes, Suliformes and Phaethontiformes. There are six species of Procelariiformes: Bulwer's Petrel *Bulweria bulwerii*, White-faced Storm-petrel *Pelagodroma marina aedesorum*, Cape Verde Shearwater *Calonectris edwardsii*, Cape Verde Storm-petrel *Hydrobates jabejabe*, Cape Verde Petrel *Pterodroma feae* and Boyd's Shearwater *Puffinus lherminieri boydi*, the last four species/subspecies being endemic to the Cabo Verde archipelago (del Hoyo *et al.* 2014). Within the Suliformes, there are two species, Magnificent Frigatebird *Fregata magnificens* and Brown Booby *Sula leucogaster*, and one species of Phaethontiform, the Red-billed Tropicbird *Phaethon aethereus* (del Hoyo *et al.* 2014). Based on bibliographic records, unpublished information and field work, this study compiled all historical and current information on the seabird species breeding in Cabo Verde archipelago, in order to: (1) map the historical and current distribution of all breeding seabird species for the whole archipelago, (2) provide a measure of relative abundance for the procellariform species using their nocturnal calls frequency in some islands and islets, and (3) describe the main breeding habitat characteristics and threats to these species. Overall, we expect: (1) main islands to currently contain a lower number of seabird species than in the past, and possess a lower diversity of seabird taxa than islets; (2) a higher relative abundance of each seabird species on inaccessible islets and more remote areas of the main islands, and (3) the majority of seabird species to occur in areas far from human settlements and in more elevated and steep areas, where accessibility to introduced invasive species and/ or human harvesting should be lower. Overall, this study compiled essential knowledge on the occurrence, relative abundance, and threats for Cabo Verde seabird populations, and provides a strong framework for applied conservation measures that should be implemented at the level of the archipelago.

Methods

Study area

This research was conducted between January 2017 and June 2019 in the Cabo Verde archipelago, located about 385 km off West Africa (Figure 1). Cabo Verde is one of the five Atlantic archipelagos that make up Macaronesia, which also includes the Azores, Madeira, Selvagens, and Canary Islands (Freitas *et al.* 2019). The archipelago is formed by 10 islands and several islets, with a total land area of 4,033 km^2, divided in relation to the trade winds into Southern (locally known as the Sotavento group) and Northern islands (locally known as the Barlavento group; see Figure 1 for toponymic details).The eastern islands are geologically older and more eroded (Sal, Boavista, and Maio) than the mountainous and newer western islands (Ramalho *et al.* 2010). All islands are of volcanic origin, but only Fogo Island has an active volcano (Dionis *et al.* 2015). The archipelago's topography ranges from plains to high mountains, reaching 2,829 m at the summit of the active volcano on Fogo Island. The elevation, slope and orientation of the mountains influence the amount of precipitation each island receives. The landscape is eroded and rugged, with vegetation mainly in inland valleys (Riva-Martínez *et al.* 2017).

Past and present distribution of seabirds in the Cabo Verde archipelago

To assess the past distribution of seabirds in the archipelago we compiled information from historical expeditions, museums, grey and scientific literature until 1995 (Table S1 in the online

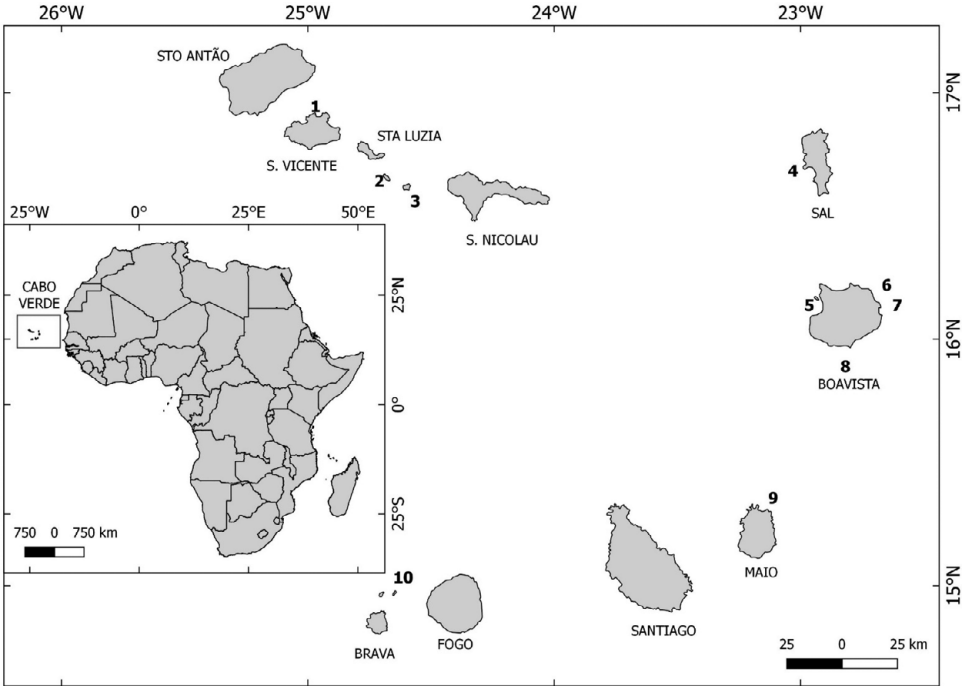


Figure 1. Map of the Cabo Verde archipelago with numbers representing the Islets of (1) Pássaros (São Vicente), (2) Branco, (3) Raso, (4) Rabo do Junco (Sal), (5) Sal Rei (Boavista), (6) Passáros (Boavista), (7) Baluarte (Boavista), (8) Curral Velho (Boavista), (9) Laje Branca (Maio), (10) Rombo (Grande, Cima, Sapado and Luís Carneiro).

Supplementary Material). To assess present distribution, nocturnal and diurnal surveys, together with some mist-netting, were carried out to identify the presence / absence of species in potential breeding sites. For nocturnal species with active calls in flight (Cape Verde Petrel, Cape Verde Shearwater, Boyd's Shearwater and Cape Verde Storm-petrel), the recognition was made through their calls for Santo Antão, São Vicente, Santa Luzia, São Nicolau, Santiago and Fogo Islands, and for Raso and Branco Islets. For the species that do not call in flight, surveys were made to locate nests of: a) Bulwer's Petrel in the Raso, Branco, and Rombo Islets at night, and b) White-faced Storm-petrel during the day in Branco, Laje Branca (Maio), Rombo, and Pássaros (Boavista) Islets. In the Cabo Verde archipelago, Phaethontiformes and Suliformes occur in the rugged coastal areas, canyons and rocky platforms of the islands and islets. Therefore, the occurrence and censuses of Red-billed Tropicbird and Brown Booby colonies were made by walking along the coast and cliffs, and by boat along the coast of Santo Antão, São Vicente, São Nicolau, Santiago, Fogo and Brava Islands, and Rabo de Junco, Curral Velho, Baluarte, Pássaros, Rombo, Branco and Raso Islets. For Sal and Boavista Islands the censuses were carried out by walking along the coast only.

Abundance of all seabirds in the Northern Islands (Barlavento group) and of Cape Verde Petrel in the whole archipelago

To identify possible breeding sites of the different procellariiform species with active calls in flight, and to assess the relative abundance of their populations, counts of nocturnal calls were made during the winter (January to April) and summer (May to December) breeding seasons of 2017–2019, at predetermined sites (Figure S1). In the Northern Islands (Santo Antão, São Vicente, Santa

Luzia, Branco, Raso and São Nicolau) the following species were censused: Cape Verde Petrel, Cape Verde Storm-petrel, Cape Verde Shearwater and Boyd's Shearwater. In the Southern Islands (Santiago and Fogo) only Cape Verde Petrel was censused. Ideally, prospections and census work should have been done similarly in all islands, but this was not possible because it demands a high number of trained fieldworkers. Prospecting locations were determined based on bibliographic records, unpublished data, and geospatial analysis of areas with potential for seabird occurrence in the archipelago, including islets, remote mountain areas, coastal cliffs and canyons. Prior to census, a site reconnaissance visit was carried out to locate and mark point-counts, and to identify the presence of birds (traces of bird droppings on rocks and nests). Information was also obtained from people living near the sampling area, including species identification (through photos and calls) and the possible threats they face at the site.

Nocturnal call counts were performed from 19h00 to 24h00, except for some cases in which they lasted until around 01h00, due to the absence of moonlight. The counts were directed only at species that visit breeding sites at night, characterized by performing calls in flight, as well as in the nest during breeding. Surveys were conducted during new moon or when the moon was not visible in the sky, because this is when most seabird species call in flight as they approach the nest (Buxton and Jones 2011) or when they come to land to perform courtship call flights (Cape Verde Petrel). At each sampling point, three censuses were performed, lasting five minutes each and with a five-minute interval between censuses. During each five-minute period, all the calls emitted by each seabird species were counted, and for the seabirds that vocalized in the five-minute intervals only their presence was recorded. Surveys were conducted by the same experienced team of fieldworkers.

Characterization of seabird habitats

All nocturnal survey sites were characterized according to their topography and land cover. Altimetric data from the Shuttle Radar Topography Mission (SRTM) 30 were downloaded in grid format from the US Geological Survey (https://earthexplorer.usgs.gov) and used to generate a 30 m Digital Elevation Model (DEM) translating into (1) elevation. From these data we calculated (2) the percentage of slope. Additionally, land use was characterised using data extracted from OpenStreetMap (OSM) (http://www.geofabrik.de) and we calculated the Euclidean distance from each land use cluster such as the distance to (3) coastline, (4) forests, (5) roads and (6) human settlements. Pixel values in a radius of 250 m around the sampling point were selected for this analysis.

Data analysis

All records published between 1783 and 1995, the year of publication of *Birds of Cape Verde* (Hazevoet 1995), representing an interval of 212 years were considered historical records. We did not include the previous work by Boessneckt and Kinzelbach (1993) about the 8th century seabird sub-fossils found on Sal Island, as this study refers to a specific period and only to this island. Records after 1995 were considered as current distribution, because most records were obtained during this study or during pilot surveys that were carried out up to seven years previously.

We georeferenced all seabird calls at point counts with a portable GPS and later mapped the distribution and relative abundance of seabird populations for each island and islet. A chi-square test of equality was used to assess whether the cumulative number of nesting species identified in the archipelago differed among 1969 (reported by Naurois 1969), 1995 (reported by Hazevoet 1995) and 2017–2019 by our surveys; significant differences would be expected if local extinction rates increased recently). A student *t*-test was used to evaluate if the current number of nesting species differs between islands and islets of the archipelago. We also correlated island size with the number of species on islands (logarithmically transformed data).

Data from the call censuses were used to assess the relative abundance of each seabird species for the islands of Santo Antão, São Vicente, Santa Luzia, São Nicolau, Santiago and Fogo, and for

Branco and Raso Islets; the average of the three calls was used for each sampling point. Kruskal-Wallis tests were used to compare median number of calls 5 min^{-1}: a) Cape Verde Shearwater, Boyd's Shearwater and Cape Verde Storm-petrel among Santo Antão, São Vicente, Santa Luzia, São Nicolau and Raso; b) Cape Verde Petrel among the islands of Santo Antão, São Nicolau, Santiago and Fogo. When significant differences were found with the Kruskal-Wallis test, a post-hoc test was used to assess pairwise differences between islands and islets. The Branco Islet was not used in these analyses because there were only two sampling points due to the inaccessibility of this islet.

The influence of habitat characteristics on the presence (1 = call) and absence (0 = no call) of (1) Boyd's Shearwater, (2) Cape Verde Petrel , (3), Cape Verde Shearwater and (4) Cape Verde Storm-petrel was tested with generalised linear models with binomial distribution, fitting the influence of (1) slope (%), (2) elevation (m), distance to (3) coastline (m), (4) forests (m), (5) roads (m) and (6) human settlements, according to the formula: 'fit' = glm (seabird presence ~ slope + elevation + dist. to coastline + dist. to forest + dist. to roads + dist. to human settlements, family = binomial (link = "logit")). The odds ratio was calculated as 'exp' (coef (mylogit)). Models were run only for data collected on Santo Antão and São Nicolau Islands, where prospections and nocturnal call surveys had a better coverage (i.e. a sufficient number of presences/ absences to allow statistical modelling). Regression models (GLMs) were run on the R platform (R Core Team 2019) using functions within the *MASS* package (Venables and Ripley 2002).

Results

Past and present seabird distribution in the Cabo Verde archipelago

The earliest reference to seabirds in the Cabo Verde archipelago was the discovery of the Boyd's Shearwater, White-faced Storm-petrel, Cape Verde Shearwater, Brown Booby and Magnificent Frigatebird sub-fossils dating from the 8th century on Sal Island (Boessneckt and Kinzelbach 1993). Several researchers who visited the archipelago over the last three centuries (Table S2), obtained formal historical records on Cabo Verde seabirds. Regarding the expeditions to Cabo Verde archipelago, the oldest records refer to the period when the naturalist João da Silva Feijó lived in the archipelago (Expedition from 1783 to 1796). Due to the poor support he received from the Portuguese authorities (Roque and Torrão 2013), the samples were not shipped to Portugal and most records were lost. Data from the National Museum of Natural History of Paris refer to expeditions to Cabo Verde from 1883 to 1970; Boyd's Shearwater, Cape Verde Storm-petrel and Bulwer's Petrel specimens were referenced and collected from Raso and Rombo Islets, similarly to accounts by Bourne (1955) and Hazevoet (1995).

Bulwer's Petrel was not reported by Alexander and Fea during their expeditions in 1897/1898 and was firstly mentioned by Correia during his first expedition to the Raso Islet in May, and to Cima Islet in June/July (Murphy 1924) (Figures 2A and 2B). Presently, the species occurs in Branco, Raso, Rabo de Junco and Rombo Islets (Figures 2C and 2D).

First records of Cape Verde Shearwaters were reported for the Branco Islet by Milne-Edwards (1883). Hazevoet (1995) reported the occurrence of this species throughout the archipelago, except for Rombo Islets, Santa Luzia, Maio and São Vicente Islands (Figures 2A and 2B). In 1990 Hazevoet confirmed two colonies with breeding individuals in eastern São Nicolau Island (Ponta da Tapadinha and Fundo de Dagu) (Hazevoet 1995). However, our surveys conducted in 2017–2018 detected this species in São Vicente Island (Monte Verde) but not in São Nicolau Island (Figure 2C). In Boavista and Sal Islands one breeding location was confirmed in their nearby islets (Curral Velho and Rabo de Junco, respectively) by Naurois (1969) and Hazevoet (1994, 1995) (Figure 2A) and by our surveys (Figure 2C). In the middle of the 20th century the largest breeding colonies for the archipelago were on Raso and Branco Islets, and smaller breeding colonies on Brava and Santo Antão Islands (Naurois 1969) (Figures 2A and 2B). This was confirmed by our present surveys

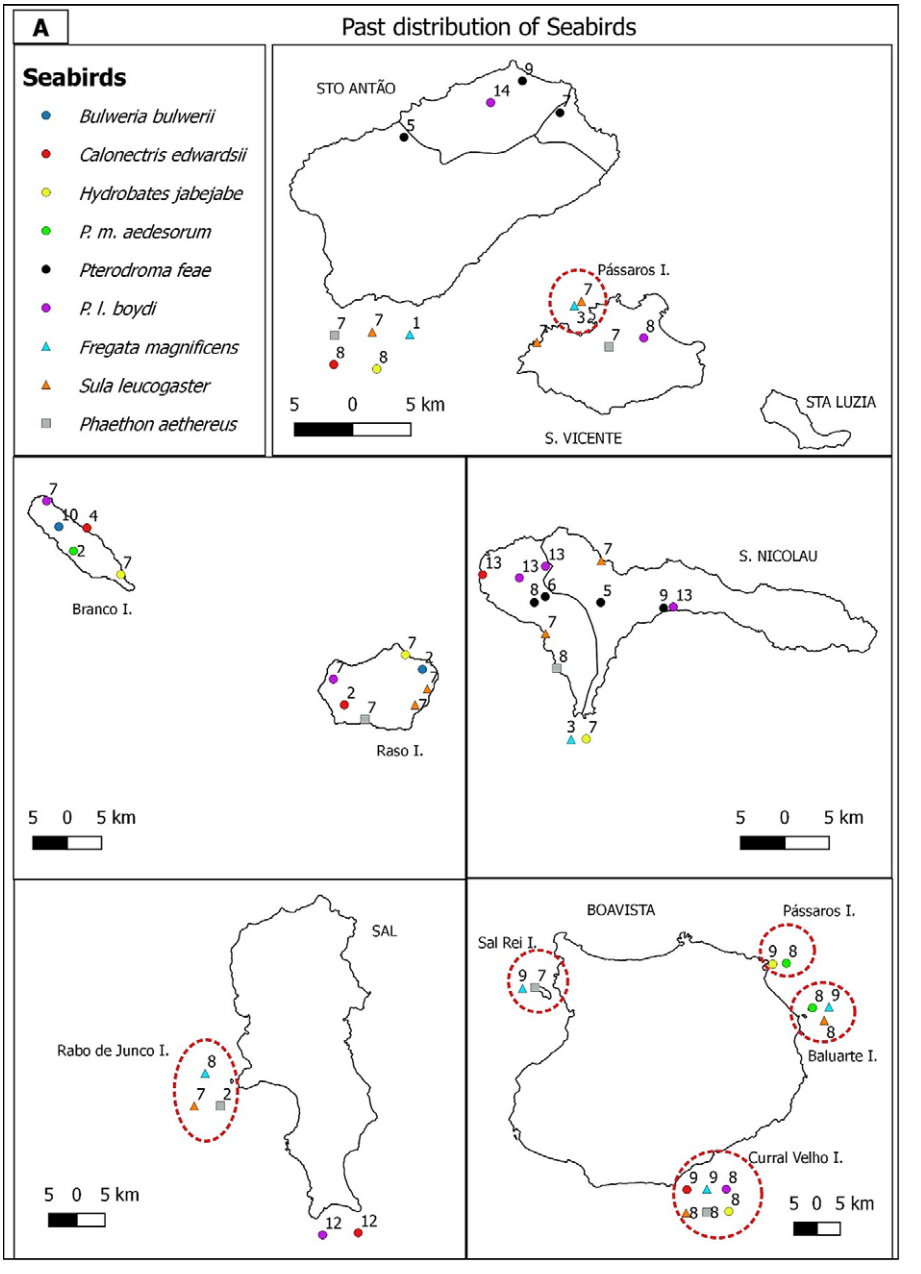


Figure 2A. Past (A, B) and current (C, D) distribution of seabirds in the Barlavento (A, C) and Sotavento (B, D) island groups of the Cabo Verde archipelago. The numbers refer to researchers who identified the species on each site: (1) MacGillivray (1852); (2) Bolle (1856) (3) Keulemans (1866); (4) Milne-Edwards (1883); (5) Salvadori (1899); (6) Bocage (1902); (7) Murphy (1924); (8) Bourne (1955); (9) Naurois (1969); (10) Naurois (1970); (11) Ledant (1988); (12) Boessneckt and Kinzelbach (1993); (13) Hazevoet (1994); (14) Hazevoet (1995). Circles represent the Procellariformes, triangles the Suliformes and squares the Phaethontiformes. Symbols laid outside the islands indicate presence but without an exact location. Islets surrounded with a dashed line.

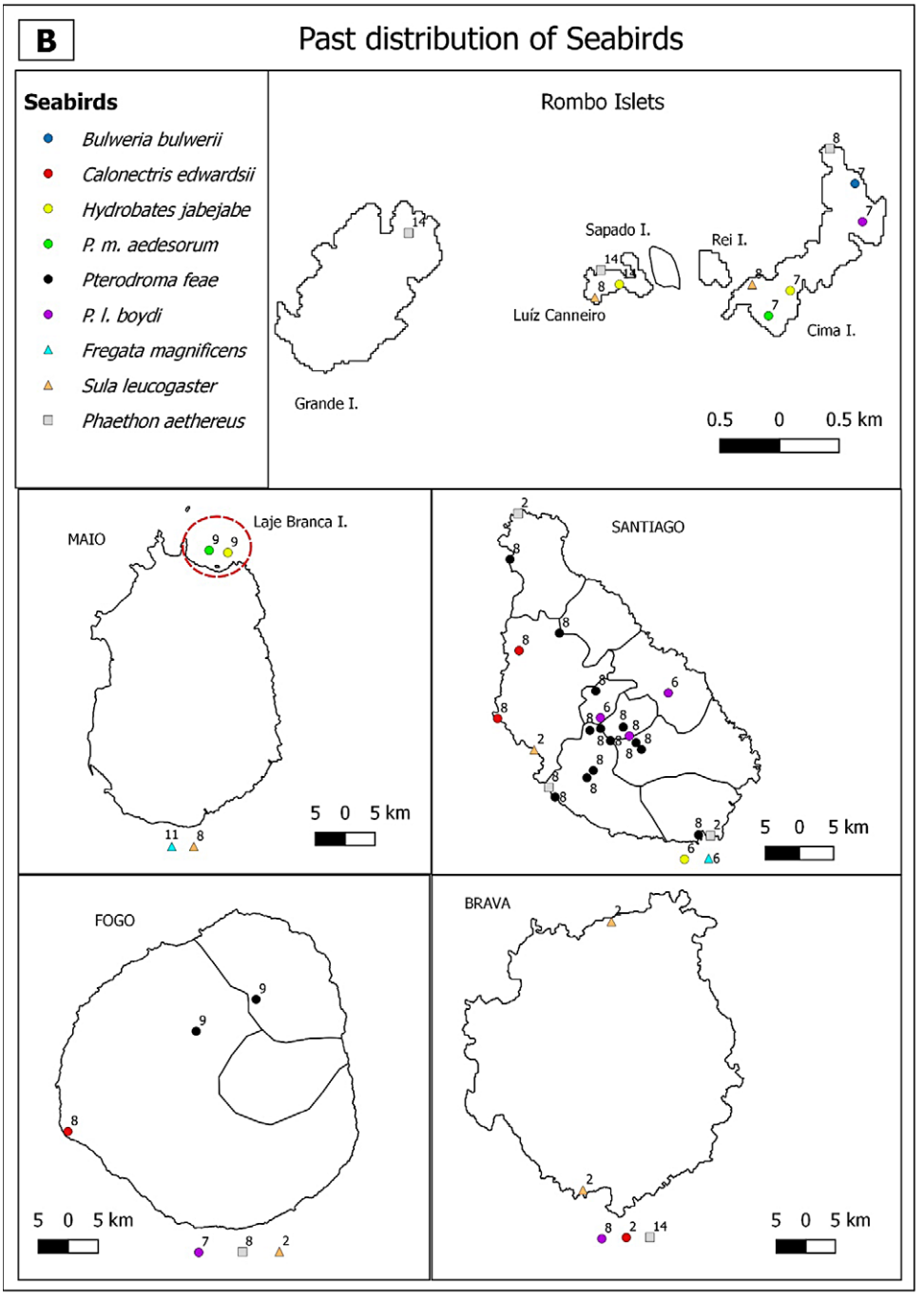


Figure 2B. Continued

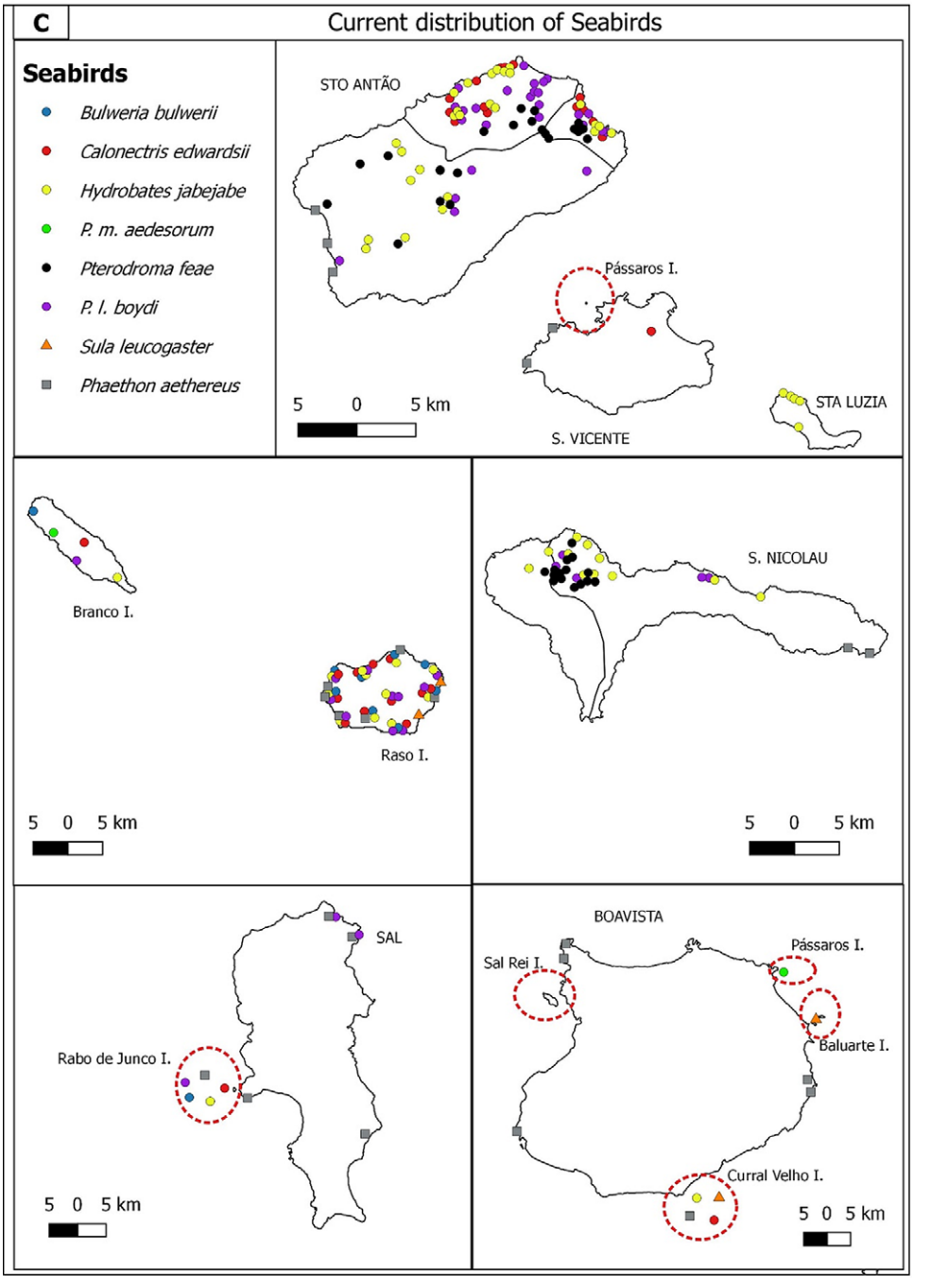


Figure 2C. Continued

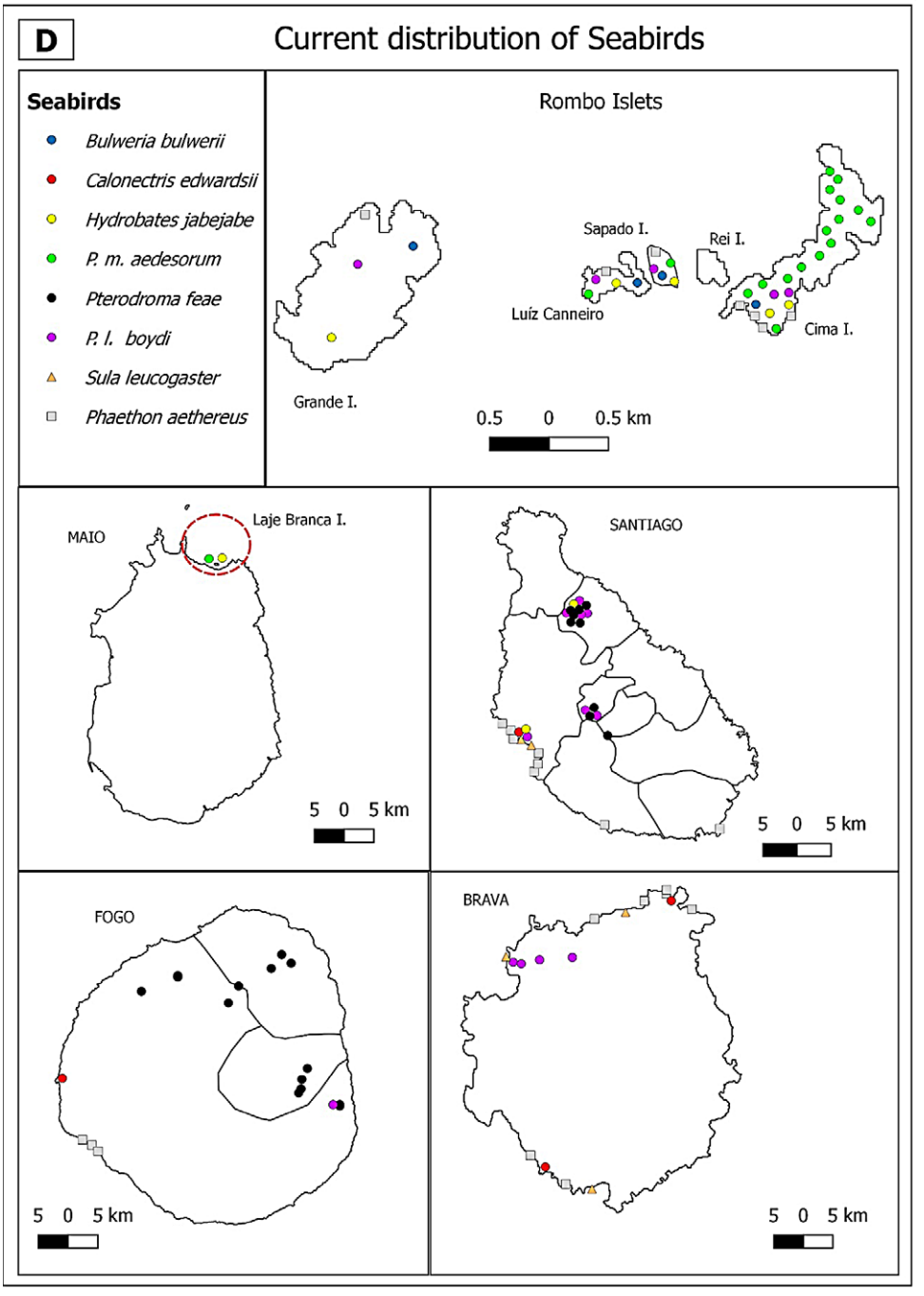


Figure 2D. Continued

(Figures 2C and 2D). The species was also reported to occur on Fogo and Santiago (Baía do Inferno) Islands, though without confirmation of breeding.

There are previous records of Cape Verde Storm-petrels throughout the archipelago, except for Santa Luzia Island (Murphy 1924, Frade 1976, Hazevoet 1994) (Figures 2A and 2B). Our surveys recorded Cape Verde Storm-petrel in Santo Antão, Santa Luzia, São Nicolau, Maio and Santiago Islands, and on Raso, Branco, Rabo de Junco (Sal), Curral Velho (Boavista) and Rombo Islets (Figures 2C and 2D). In Baía de Inferno (Santiago) several individuals were heard and in Laje Branca Islet (Maio) several birds were captured with mist-nets.

The White-faced Storm-petrel was recorded on Rombo (Cima), Branco, Pássaros (Boavista) and Laje Branca (Maio) Islets by Bourne (1955) and Hazevoet (1995) (Figures 2A and 2B). On Santa Luzia Island one specimen was collected by Murphy (1924). Presently, nests were located on Branco, Pássaros (Boavista), Laje Branca (Maio) and Cima Islets (Figures 2C and 2D). This species may also occur on Sapado and Luiz Carneiro Islets, but more surveys are needed to confirm its presence.

The reproduction of Cape Verde Petrel on Santo Antão and São Nicolau Islands was confirmed by Leonardo Fea (in Salvadori 1899) during the American expedition of "The Blossom" (in Murphy 1924). On Fogo and Santiago Islands, the presence of this species was already known through the records of inhabitants and Fea (Bourne 1955) (Figures 2A and 2B). Naurois (1969) confirmed the breeding areas of this species and determined the altitude at which they occurred on São Nicolau (600 m) Fogo (2,200 m) and Santiago (400–800 m) islands. Our surveys indicate that currently this species occurs at different elevations: in Santo Antão (905–1,465 m), São Nicolau (603–708 m), Fogo (439–2,222 m) and Santiago (356–581 m) islands (Figures 2C and 2D).

Boyd's Shearwater was reported as abundant on Raso, Branco, and Cima Islets by Correia (cited by Murphy 1924). On Santiago Island, the species was first recorded by Leonard Fea (in Salvadori 1899) and confirmed by Naurois (1969). On Curral Velho Islet (Boavista), the species was confirmed by Naurois in March 1968. This species was described as having a wider distribution at the archipelago, except for Maio and Luzia Islands (Naurois 1969) (Figures 2A and 2B). Presently, Boyd's Shearwater occurs in Santo Antão, São Nicolau, Sal (Furna and Cadjetinha), Santiago, Fogo and Brava Islands, Branco, Raso, Rabo de Junco (Sal) and Rombo Islets group (Figures 2C and 2D).

There are records of Brown Booby in 1786 for Fogo Island (Roque and Torrão 2013), and Bourne (1955) and Naurois (1969) refer to this species for Brava, Santiago, Maio and Boavista Islands, and Rombo and Raso Islets but considered it absent on Santa Luzia Island (Figures 2A and 2B). Hazevoet (1995) refers to the possibility of reproduction in Santo Antão, São Vicente, Sal and Fogo Islands but did not provide details. During the 20th century several authors refer to the decline in the number of individuals on the Rombo Islets due to human predation (Hazevoet 1995). During our surveys Brown Booby was identified on Santiago (Baía do Inferno) and Brava islands, and Raso, Baluarte and Curral Velho Islets (Figs. 2C and 2D). On São Nicolau Island local fisherman mentioned a colony of Brown Booby, but this was not confirmed. Its current absence was also confirmed on Cima and Grande Islets (Rombo Islets group).

The earliest historical records of Red-billed Tropicbird are on Santiago Island (Keulemans 1866). In the 20th century this species was reported on Branco, Raso, Rabo de Junco and Rombo (Cima and Grande) Islets, and for all Islands except Maio and Santa Luzia (Frade 1976, Hazevoet 1995) (Figs. 2A and 2B). Our surveys identified Red-billed Tropicbird on Santo Antão, São Vicente, São Nicolau, Sal, Boavista, Santiago, Fogo and Brava Islands, and on the islets of Raso, Rabo de Junco (Sal), Curral Velho (Boavista) and all Rombo Islets. On the Island of Fogo, Red-billed Tropicbird colonies were identified in some cliffs south of São Filipe Island and on Pena Islet, also nearby São Filipe (Projecto Vitó NGO pers. comm.), but the population size was not estimated due to the difficult access. Several Red-billed Tropicbird populations were confirmed on Boavista Island, on Ponta do Sal, Ponta Rincão, Varandinha, Morro Negro and Ponta do Roque (López-Suárez 2012) and on Sal Island, in Serra Negra, Furna, Cadjetinha and Monte Leão. We also confirmed 50 individuals on Santo Antão Island between Tarrafal and Monte Trigo, in three groups (10, 20, 20),

35 individuals on a cliff in São Vicente Island between Baía do Mindelo and Farol de São Pedro, and less than 10 individuals in the southern part of São Nicolau Island. On Brava Island we confirmed four colonies, but in just one of those we could count 15 individuals in flight (Figures 2C and 2D).

Although the Magnificent Frigatebird is currently extinct in the Cabo Verde archipelago, in the past it occurred on Pássaros Islet (São Vicente), Santo Antão, São Nicolau (Keulemans 1866) on Rabo de Junco Islet (Murphy 1924), Curral Velho and Baluarte Islets (Boavista) and Maio(Naurios 1969) (Figures 2A and 2B). The last successful breeding of the species in the archipelago occurred in 1998 (López-Suárez *et al.* 2005). The species made several breeding attempts in the following years, with unhatched eggs. Two females and one male were sighted in 2015 and just two females the following year, the last record of the species in the archipelago (Pedrin López-Suárez pers. comm.).

Overall, Hazevoet (1995) recorded a cumulative number of 52 breeding species on islands and islets of the archipelago (one species per Island/ Islet), and our study recorded a number of 57 species (considering the Rombo Islet as a sampling unit, similarly to the records of Naurois and Hazevoet). However, if we add each islet of the Rombo group separately (Cima, Grande, Luiz Carneiro, and Sapado) the cumulative number increases to 71 breeding species. We found no difference in the cumulative number of breeding seabird species per island and islet of Cabo Verde among 1969 ($n = 55$ species), 1995 ($n = 52$ species) and 2019 ($n = 57$ species; $\chi^2_2 = 2.08$; $P = 0.83$). We also found no significant difference between the number of seabird species currently occurring on islands (10 islands and an average of 2.9 species per island) and islets (13 islands and an average of 3.3 species per Islet; $t_{21} = -0.46$; $P = 0.64$). There was no correlation between island size and number of species (r = 0.58; $P = 0.07$, $n = 10$). The two most mountainous islands of the archipelago, Santiago, and Santo Antão, possessed the largest number of seabird species (six and five, respectively), followed by São Nicolau, Fogo and Brava with four species on each island (Table 1). Cape Verde Petrel is the only species absent from islets.

Relative abundance of Cape Verde Shearwater, Cape Verde Storm-petrel, Boyd's Shearwater and Cape Verde Petrel

Call surveys on the islands of the Barlavento group revealed that Cape Verde Shearwaters were relatively more abundant on Raso Islet followed by São Vicente, and Santo Antão Islands (mean nº of calls 5 min^{-1} = 14, 3 and 1, respectively; Figure 3A). There was an almost significant difference in median number of calls 5 min^{-1} among Raso Islet, Santo Antão, São Vicente, Santa Luzia and São Nicolau Islands (Kruskal-Wallis: $H_4 = 8.82$; $P = 0.066$; $n = 92$).

The largest density of Boyd's Shearwater was present on Raso, followed by Santo Antão and São Nicolau (mean nº of calls 5 min^{-1} = 19, 3 and 1, Figure 3B). The Kruskal-Wallis test showed a significant difference in the median number of calls 5 min^{-1} by Boyd's Shearwater among Santo Antão, São Vicente, São Nicolau, Santa Luzia Islands and Raso Islet (K-W: $H_4 = 39.5$; $P < 0.001$; $n = 185$). Post-hoc test showed that the relative abundance of Boyd's shearwater was higher on Raso Islet than on other islands ($P < 0.001$). Cape Verde Storm-petrel occurred in largest densities on Raso Islet, followed by São Nicolau, Santo Antão, and Santa Luzia Islands (mean nº of calls 5 min^{-1} = 72, 25, 10, 1, respectively; Figure 3C). The Kruskal-Wallis test showed a significant difference in the median number of calls 5 min^{-1} by Cape Verde Storm-petrel among Raso Islet, Santo Antão, São Vicente, São Nicolau and Santa Luzia Islands (K-W: $H_4 = 17.8$; $P = 0.001$; $n = 92$). Post-hocs revealed that relative abundance of Cape Verde Storm-petrel was higher on Raso Islet than on Santo Antão, São Vicente and São Nicolau Islands ($P < 0.01$). Population relative density of Cape Verde Petrel was higher on Santo Antão, followed by São Nicolau, Fogo and Santiago Islands (mean nº of calls 5 min^{-1} = 22, 21, 18, 16, respectively; Figures 4A and 4B). The Kruskal-Wallis test showed a significant difference in the median number of calls 5 min^{-1} by Cape Verde Petrel among Santo Antão, São Nicolau, Santiago and Fogo Islands (K-W: $H_3 = 27.1$ $P < 0.001$; $n = 190$), but the post-hoc test was unable to identify differences among islands.

Table 1. Current number of seabird species per Island/Islet in the Cape Verde archipelago. BB – Bulwer's Petrel *Bulweria bulwerii*; CE – Cape Verde shearwater *Calonectris edwardsii*; HJ – Cape Verde storm-petrel *Hydrobates jabejabe*, PM – White-faced storm-petrel *Pelagodroma marina aedesorum*; PF – Cape Verde petrel *Pterodroma feae*; PB – Boyd´s shearwater *Puffinus lherminieri boydi*; SL – Brown booby *Sula leucogaster* and PA – Red-billed tropicbird *Phaethon aethereus*.

Location	Area Km²	Species	Number of species	Population Density (Inhabitants Km⁻²)
Islands				
Santo Antão	779	CE, HJ, PB, PF, PA	5	50.48
São Vicente	227	CE, PA	2	364.23
Santa Luzia	35	HJ	1	0
São Nicolau	343	HJ, PB, PF, PA	4	35.74
Sal	216	PB, PA	2	170.23
Boavista	620	PA	1	26.81
Maio	269	-	0	26.43
Santiago	991	CE, HJ, PB, PF, SL, PA	6	304.64
Fogo	476	CE PB, PF, PA	4	35.74
Brava	64	CE, PA, SL, PB	4	50.48
Islets				
Pássaros (São Vicente)	-	-	0	0
Branco	3	BB, CE, HJ, PM, PB,	5	0
Raso	7	BB, CE, HJ, PB, SL, PA	6	0
Rabo de Junco (Sal)	0.02	BB, CE, HJ, PB, PA	5	0
Pássaros (Boavista)	0.007	PM	1	0
Baluarte (Boavista)	0.06	SL	1	0
Curral Velho (Boavista)	0.0077	CE, HJ, SL, PA	4	0
Sal Rei (Boavista)	0.6	-	0	0
Laje Branca (Maio)	0.05	PM, HJ	2	0
Cima (Rombo)	1.5	BB, HJ, PB, PM, PA	5	0
Grande (Rombo)	3	BB, HJ, PB,PA	4	0
Sapado (Rombo)	-	BB, HJ, PM, PB, PA	5	0
Luiz Carneiro (Rombo)	0.22	BB, HJ, PM, PB, PA	5	0

Habitat characteristics determining the seabird presence in Santo Antão and São Nicolau

As elevation and distance to coast decreased, Boyd's Shearwater was 2.08 and 1.69 times more likely to occur, respectively. Cape Verde Petrel was 4.12, 3.01, and 2.05 times more likely to occur with increasing elevation, distance to coastline and distance to human settlements, respectively. Plus, this species was 3.87 times more likely to occur with decreasing distance to forest areas. Cape Verde shearwaters was 1.54, 1.69 and 1.84 times more likely to occur as elevation, distance to coastline and distance to roads decreases, respectively. As elevation and slope increased, Cape Verde Storm-petrel was 3.84 and 4.01 times more likely to occur, respectively (Table 2).

Discussion

Seabird distribution and abundance

Currently, the Cabo Verde archipelago holds populations of all seabird species referred to two centuries ago except the Magnificent Frigatebird, which has not been recorded in the Cabo Verde archipelago since February 2014 (López-Suárez *et al.* 2012, Hazevoet 2014), and the compilation of our data points to its extinction in the archipelago. The initial decline of the Magnificent Frigatebird population in Cabo Verde was likely triggered by human persecution (Hazevoet 1994, 1995, López-Suárez *et al.* 2005).

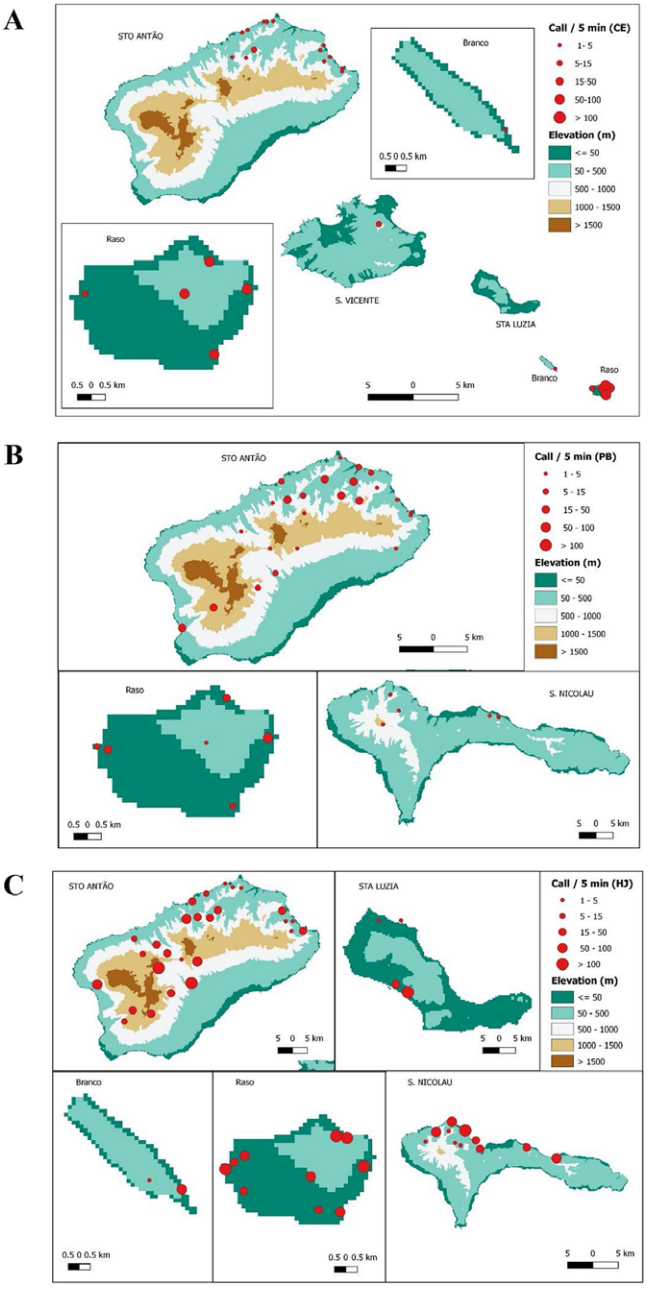


Figure 3. Map of the relative abundance of (A) Cape Verde shearwater *Calonectris edwardsii* (CE), (B) Boyd's shearwater *Puffinus lherminieri boydi* (PB) and (C) Cape Verde-storm petrels *Hydrobates jabejabe* (HJ) in the Santo Antão, São Vicente Islands and Branco and Raso Islets.

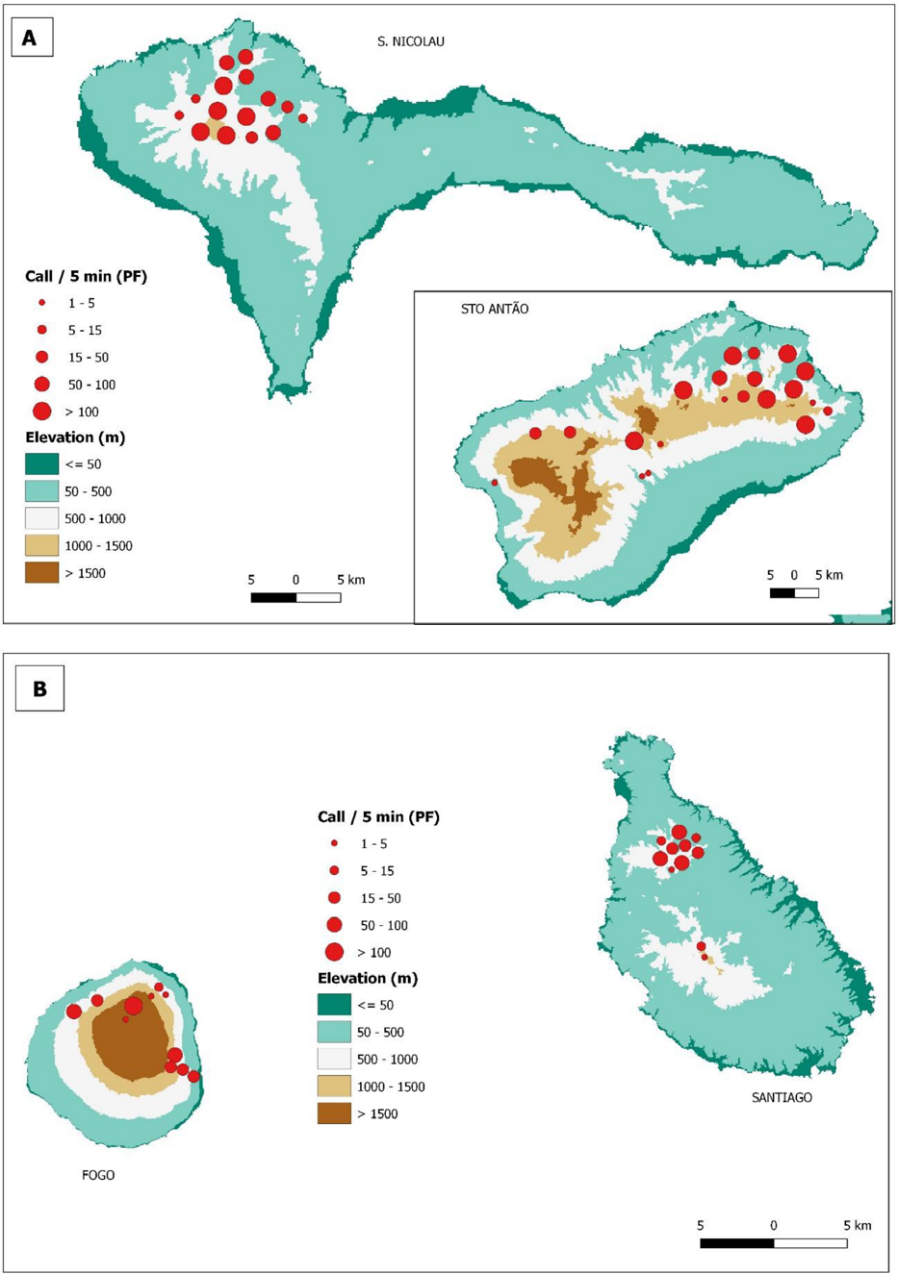


Figure 4. Map of the relative abundance of Cape Verde petrel *Pterodroma feae* (PF) in (A) Santo Antão and São Nicolau and (B) Santiago and Fogo Islands.

Our study reports a slightly higher number of seabird species for islets than for islands: the main seabird populations are located on Raso, Branco, Rabo de Junco and Rombo Islets. Branco and Raso are particularly important for seabird populations given the orographic characteristics of the islets, strong marine currents and large swells (Lopes *et al.* 2015), and the absence of large freshwater

Table 2. General linear models (GLM) with binomial distribution, fitting the influence of habitat characteristics on the presence (1) or absence (0) of (a) Boyd's shearwater *Puffinus lherminieri boydi,* (b) Cape Verde petrel *Pterodroma feae,* (c) Cape Verde shearwater *Calonectris edwardsii* and (d) Cape Verde-storm petrel *Hydrobates jabejabe* on Santo Antão and São Nicolau Islands. Mean values ± SD. OR, odds ratio. Significant differences (P < 0.05) marked in bold.

a) Boyd's shearwater *Puffinus lherminieri boydi*

Parameter	**β ± SE**	**Z**	**P**	**OR**	**Presence (n=33)**	**Absence (n=123)**
Intercept	**0.91±1.22**	**1.12**	**0.02**	**0.98**	—	—
Slope (%)	–0.12±0.28	0.92	0.25	0.34	14.3±5.2	14.6±7.0
Elevation (m)	**–1.98±0.87**	**2.67**	**0.01**	**2.08**	**364.8±183.0**	**634.2±162.3**
Dist. to coastline (m)	**–1.71±0.28**	**3.01**	**0.001**	**1.69**	**1119.7±856.3**	**2252.0±902.9**
Dist. to forest (m)	0.12±0.84	0.13	0.10	1.01	3193.7±1685.5	3296.3±1704.2
Dist. to roads (m)	0.08±0.11	0.76	0.37	0.33	264.5±164.4	307.6±122.9
Dist. to Human settlements (m)	0.11±0.66	0.14	0.68	0.74	2623.8±908.3	2784.8±951.1

b) Cape Verde petrel *Pterodroma feae*

Parameter	**β ± SE**	**Z**	**P**	**OR**	**Presence (n=40)**	**Absence (n=116)**
Intercept	0.67±0.45	0.54	0.57	0.27	—	—
Slope (%)	0.54±0.68	0.98	0.17	0.66	15.4±4.7	17.2±7.2
Elevation (m)	**3.12±1.33**	**3.88**	**<0.001**	**4.12**	**866.0±230.1**	**434.6±341.0**
Dist. to coastline (m)	**2.14±0.87**	**4.01**	**0.001**	**3.01**	**4676.1±1456.4**	**2819.8±1013.0**
Dist. to forest (m)	**–1.99±1.08**	**6.42**	**<0.001**	**3.87**	**918.2±275.0**	**2418.4±1052.4**
Dist. to roads (m)	0.28±0.33	1.02	0.27	0.39	458.7±78.7	480.4±99.1
Dist. to Human settlements (m)	**1.01±0.77**	**4.91**	**0.001**	**2.05**	**3341.3±987.1**	**1961.0±1015.9**

c) Cape Verde shearwater *Calonectris edwardsii*

Parameter	**β ± SE**	**Z**	**P**	**OR**	**Presence (n=10)**	**Absence (n=59)**
Intercept	**–1.01±0.64**	**2.09**	**0.03**	**0.88**	**—**	**—**
Slope (%)	0.17±0.09	0.22	0.64	0.45	15.7±3.6	16.5±6.3
Elevation (m)	**–1.07±0.87**	**2.15**	**0.01**	**1.54**	**283.6±118.2**	**439.9±150.3**
Dist. to coastline (m)	**–1.84±0.38**	**8.19**	**<0.001**	**1.69**	**1523.9±818.6**	**2931.1±931.4**
Dist. to forest (m)	0.08±0.15	0.87	0.45	0.39	1360.5±399.3	1817.8±597.0
Dist. to roads (m)	**–2.70±0.87**	**4.10**	**0.001**	**1.84**	**196.9±72.4**	**213.3±113.4**
Dist. to Human settlements (m)	0.09±0.15	0.77	0.39	0.99	2107.6±909.6	2019.3±1136.3

d) Cape Verde storm-petrel *Hydrobates jabejabe*

Parameter	**β ± SE**	**Z**	**P**	**OR**	**Presence (n=28)**	**Absence (n=41)**
Intercept	0.12±0.69	0.98	0.69	0.57	—	—
Slope (%)	**2.58±0.32**	**7.01**	**<0.001**	**3.84**	**35.3±5.2**	**15.1±6.8**
Elevation (m)	**1.47±0.64**	**6.34**	**<0.001**	**4.01**	**866.7±214.6**	**460.9±132.4**
Dist. to coastline (m)	0.45±0.17	1.72	0.97	0.94	2833.8±1741.8	2864.8±1568.9
Dist. to forest (m)	0.06±0.37	0.63	0.67	0.35	1843.0±891.5	1970.4±880.5
Dist. to roads (m)	0.17±0.22	0.81	0.45	0.77	264.5±94.9	253.2±147.3
Dist. to Human settlements (m)	0.28±0.27		0.83	0.64	2696.0±1324.2	2466.3±1234.4

springs, which prevented colonisation by humans (Gomes *et al.* 2015). The difficulty of landing on Branco and Raso kept these islets under less anthropogenic pressure and without exotic mammals such as rats and cats, unlike the nearby Santa Luzia Island, whose extensive beach areas allowed

easier human landings and the expansion of cats and rats (Oliveira *et al.* 2013). Vocalization data from the Barlavento group suggest that, as expected, populations are more abundant on Raso Islet (and possibly on Branco Islet, but there were insufficient data) than on the nearby islands of São Nicolau, São Vicente, and Santo Antão. Therefore, the lower anthropogenic pressure combined with the absence of mammalian predators on the islets, should be the most important factors to explain these results. Overall, introduced mammalian predators directly influence the abundance of seabird populations, may lead to breeding habitat modification and loss, and cause local extinction of species on islands and islets around the world (Nogales *et al.* 2013, Xu *et al.* 2016). Seabird populations are present on all but one island of the Cabo Verde archipelago, Maio Island. A possible reason for this could be the impact of cows, goats, and sheep grazing freely on Maio Island since 1490 (Santos and Semedo 2006) causing habitat degradation. The other reason is that Maio Island presents a soft relief and large flat areas, similarly to the islands of Sal and Boavista (INE 2017). However, in addition to flat areas, both Sal and Boavista have more elevated and rocky coastal cliffs, which helps to explain why these islands also hold breeding populations of Red-billed Tropicbird and Boyd's Shearwater.

As expected, larger species had a wider distribution along the archipelago, but small procellariformes such as the Cape Verde Storm-petrel occur on islands with rugged relief, mainly in mountainous sites and steep cliffs, where introduced cats and rats are less likely to be present. They also occur only on rat- and cat-free islets, except Santa Luzia Island (where mice and cats are present) and Rombo Islet (mice are present). Similar results were obtained elsewhere, notably in the Azores, with populations of Band-rumped Storm-petrel *Hydrobates castro* and Audubon's Shearwater *Puffinus baroli* present in rugged and inaccessible locations on several inhabited islands such as Flores and São Miguel (Monteiro *et al.* 1999). The Cape Verde Petrel is confined to the mountainous islands of Santo Antão, São Nicolau, Santiago, and Fogo, as reported by Hazevoet (1995) and Ratcliffe *et al.* (2000). The White-faced Storm-petrel and Bulwer's Petrel are the only species restricted to islets. The breeding distribution of White-faced Storm-petrel is limited by the availability of nesting habitat because it needs sand to build its nest (Tavares and Ratão 2017). We could not evaluate the distribution of Bulwer's Petrel effectively as it does not call in flight when arriving at the breeding sites (Monteiro *et al.* 1999).

Currently, Brown Booby is absent in Santo Antão, São Vicente and São Nicolau islands and on Cima Islet but in the past, it occurred there in large numbers. For instance, Murphy (1924) refers to them occurring in large numbers on Santa Luzia Island and thousands of individuals on Rombo Islets. Numbers were so large that the guano was used by the inhabitants of Brava in their plantations as well as exported to Lisbon and South America. We also did not detect Cape Verde Shearwater on São Nicolau Island, Cape Verde Storm-petrel on Pássaros Islet (Boavista) and Boyd's Shearwater on Curral Velho Islet. The reasons for the apparent local extinction of these species in these islands and islets could be human capture and breeding habitat modification (Hazevoet 1995). Again, one century ago Murphy (1924) refers to Cima as holding "thousands of Brown Booby on this island, although the fishermen slaughter great numbers for food" and to Raso Islet as being an islet where "great numbers of maritime birds come to breed, and the human visitors often kill more birds than fish".

Habitat characteristics determining seabird occurrence on islands

As expected, Boyd's Shearwater and Cape Verde Shearwaters were distributed on low elevation areas and closer to the coastline. These are some of the species more easily recognized by local people, especially on islands where relative densities were higher, like Santo Antão. Such habitat characteristics also drive the selection of nests of other burrowing breeders, such as the Sooty Shearwater *Ardenna grisea* from the South Pacific (Clark *et al.* 2019). Moreover, in the Canary Islands, the related Macaronesian Shearwater *Puffinus lherminieri baroli* and Cory's Shearwater *Calonectris borealis* are rescued in higher numbers, when compared to other seabirds, in areas close to the coastline and human settlements, after fledglings (mostly) are attracted by artificial lights (Rodriguéz *et al.* 2012). The lower relative abundances of both species when compared to Cape

Verde Storm-petrel might be partially explained by a higher level of historical human predation of larger species occurring closer to human settlements/ activities. Cape Verde Petrel and Cape Verde Storm petrels were only detected at high elevation and remote areas (far from the coastline and roads). Higher elevation and remoter areas are also the characteristic habitat driving the occurrence of other gadfly petrels, like the endangered Trindade Petrel *Pterodroma arminjoniana* (Krüger *et al.* 2018) and mid-size petrels, like the South Georgia Diving-petrel *Pelecanoides georgicus* (Fisher *et al.* 2017). Overall, seabird populations were mostly confined to specific and restricted habitats, giving strength to the idea that historical and current human-based interference (e.g. capture, disturbance and introduction of alien predators) might have forced them to those remoter and mostly inaccessible areas (e.g. Probst *et al.* 2000, Rayner *et al.* 2007).

Threats to seabirds in Cabo Verde

The introduction of alien mammal species, such as cats, rats, mice and even dogs to the Cabo Verde Islands devastated historically large seabird populations. This has been reported for Santa Luzia (Naurois 1969, Oliveira *et al.* 2013) and for Fogo Islands (Ratcliffe *et al.* 2000, Militão *et al.* 2017) and Grande Islet (Murphy 1924). Habitat loss and modification due to anthropogenic actions was particularly important for Pássaros (São Vicente) and Sal Réi (Sal) Islets. Pássaros Islet harboured Magnificent Frigatebird and Brown Booby colonies in the 19th century (Keulemans 1866), but after its use for military purposes and construction of the lighthouse (Hazevoet 1995), both seabird colonies were extirpated. In Sal Réi Islet the construction of the lighthouse may also explain the absence of seabirds. Historically, Santa Luzia Island had large colonies of several seabird species, but for two centuries only Cape Verde Storm-petrel still breeds there (Bourne 1955, Hazevoet 1995). It appears that the strong presence of mammal domestic herds during the 19th and until mid-20th centuries (Melo *et al.* 2015) led to habitat destruction on this 35-km^2 island: in 1880 the presence of 100 cows, 600 goats, 350 sheep, 13 donkeys and 24 other domestic animals were reported here (Pina 2010). On the other hand, the recent record of Cape Verde Storm-petrel in the steep cliff areas of Santa Luzia (Oliveira *et al.* 2013) after two centuries without recording seabirds on this island, indicates that remnant seabird populations may persist in steep and remote locations. Similarly, Grande Islet, the largest of the Rombo Islets, housed large colonies of seabirds in the past, as indicated by the thick layers of guano (Murphy 1924). The presence of goats altered the natural habitat of this Islet. Presently, the loss of breeding habitat could be a major reason for the absence of breeding seabird populations on Pássaros Islet (São Vicente Island) and on Sal Rei Islet (Sal Island). Presently, on the most populated islands, seabirds are mainly found in areas almost inaccessible to humans such as Baía of Inferno (Santiago), Monte Pico of Antonia (Santiago), Monte Santinha (São Nicolau), and Bordeira (Fogo).

Droughts and famines have persisted in the Cabo Verde archipelago since its colonization, and several extreme events took place throughout the 17th, 18th and 19th centuries which decimated many domestic animals and people (Caniato 2006). Hunting of wild species, including seabirds, resulted from the island's low level of natural resources, cyclical drought and famine events that plagued the Cabo Verde archipelago (Naurois 1969). For the decline of seabird populations in the archipelago, predation of eggs and birds by the inhabitants was relevant, as reported by Murphy (1924) and Hazevoet (1995). During the two weeks that Murphy (1924) remained on Raso Islet he noted the killing of 3,000 Cape Verde Shearwaters by fishermen. The slaughter of thousands of seabirds on this islet during the reproductive period was common until 2006/07, mainly by fishermen from Santo Antão, São Vicente, and São Nicolau Islands (Rendall and Pile 2007), when the NGO Biosfera began protection and monitoring campaigns (Melo 2011). BirdLife International (2019) reports that populations of Pelecaniformes and Suliformes on the Rombo Islets has declined dramatically over the past 100 years due to excessive human predation. Murphy (1924) refers to thousands of individuals inhabiting the islets in 1922, and in the early 1950s there were still many hundreds. Between 1986 and 1990 there were only 50 pairs of Brown Boobies and 5–10 pairs of Red-billed Tropicbirds (Hazevoet 1995) and currently there is no record of Brown Booby. On Cima

Islet, we confirmed the capture of Red-billed Tropicbirds by humans and we found tools to capture other seabird species (e.g. Cape Verde Shearwater) in Curral Velho in 2019. Despite recent conservation efforts, there are still some recent reports of human predation and vandalism of Red-billed Tropicbird on Sal and Boavista Islands, of Cape Verde Petrel on Fogo and Santo Antão Islands (Ratcliffe *et al.* 2000), and of Cape Verde Shearwater and Brown Booby (Tosco 2000, López-Suárez 2012).

During this study we recorded the predation of Cape Verde Shearwater chicks on Raso Islet and White-faced Storm-petrel on Cima Islet by ghost crab *Ocypode cursor.* Seabird predation by ghost crabs was historically reported by Murphy (1924), who reports the species could spend all night predating on seabirds and arguing the crabs could subsist mostly on seabird flesh. Eggs of Boyd's Shearwater and Bulwer's Petrel were also scavenged by giant gecko *Tarentola gigas* on Raso and Branco Islets. In fact, Lopes *et al.* (2019) confirmed the presence of Cape Verde Shearwater, Bulwer's Petrel and Red-billed Tropicbird DNA in the giant gecko faeces. The apparent predation of eggs and hatchlings of Boyd's Shearwater, Bulwer's Petrel, Red-billed Tropicbird and Cape Verde Shearwater by Brown-necked Raven *Corvus ruficollis* and Neglected Kestrel *Falco tinnunculus neglectus* on Raso Islet have yet to be confirmed (Isabel Rodrigues pers. comm.). Osprey *Pandion haliaetus* on Raso Islet appears to prey on Boyd's Shearwater, Bulwer's Petrel and Cape Verde Shearwater, because remnants of these species were found in Osprey nests.

Volcanic eruptions can also cause habitat alteration for nesting seabird species on Fogo Island. Historical records of volcanic eruptions on the Fogo Island from 1500 to 2014 show that there were about 31 events (INE 2018). However, only for the 1995 eruption is there reference to the destruction of Fea´s Petrel breeding grounds (Hazevoet 1995). However, we do not have proof of nests being destroyed during the most recent eruption on the island (2014), though this might have happened in the past.

A new aspect of human interference is the introduction of electricity (and artificial light) into the remotest locations of Cabo Verde Islands. In 2017, about 90% of the resident population already had access to electricity (INE 2017). In the past, residents of the archipelago used to build bonfires to attract seabirds on their return to the colonies (Ratcliffe *et al.* 2000), as was done in the Azores archipelago (Monteiro *et al.* 1996). Light pollution affects seabird populations worldwide and may contribute to the effective decline of these populations attracted by street lighting (Le Corre 2008, Rodríguez *et al.* 2015a, Rodríguez *et al.* 2015b). In Cabo Verde, seabirds disoriented by illumination can after landing be captured either by introduced mammals (e.g. cats) or by humans (Ratcliffe *et al.* 2000, African Bird Club 2020). Street lighting can also disrupt the trajectory of Cape Verde Petrel in its return to breeding colonies and may constrain the availability of breeding habitat (Militão *et al.* 2017). Nowadays, seabirds in the archipelago continue to face the same threats reported in the past by Hazevoet (1995), though human predation appears to have diminished. Predation by alien mammals is still noticeable, especially by rats and cats on Santa Luzia Island (Medina *et al.* 2012, Oliveira *et al.* 2013), cats on all islands where Cape Verde Petrel breeds and dogs on Sal Island (unpubl. data). Recently, green monkeys *Chlorocebus sabaeus* were introduced onto Santiago and Fogo not far from Cape Verde Petrel breeding colonies, which adds another threat to the list. Overall, further studies are needed to measure the impact of introduced invasive species on seabirds. In general, the current distribution and abundance of seabirds in the archipelago is the result of a combination of factors such as threats (human predation, habitat modification and introduction of invasive species) and habitat characteristics (elevation, distance to forest areas, coastline, human settlements and slope).

Further research

We are confident the historical data included in this work represents an exhaustive compilation of the available knowledge on the past seabird distribution in Cabo Verde. Nevertheless, mapping the current distribution and abundance needs (1) further surveys and counts of nocturnal calls in flight on Sal, Boavista, Santiago, Fogo, Maio, and Brava islands, to confirm whether the abundance patterns

found for the Northern Islands are similar to those on the Southern Islands; (2) deployment of automatic recorder units (ARUs) on islands/locations where higher relative abundances were reported, to calculate abundances of the different seabird species from vocalization rates; (3) deployment of ARUs on areas less prospected but with habitat characteristics suitable for the occurrence of seabird species (e.g. steeper cliffs); (4) further detailed prospections of breeding areas and nest counts on all islets and islands; (5) population estimates by capture-mark-recapture methods, in particular for small species such as storm-petrels, whose nests are difficult to find or count.

Supplementary Materials

To view supplementary material for this article, please visit http://dx.doi.org/10.1017/S0959270920000428.

Acknowledgements

This work received financial and logistic support from the project Alcyon – Conservation of seabirds from Cabo Verde, coordinated by BirdLife International and funded by the MAVA Foundation pour la nature (MAVA17022; http://en.mava-foundation.org), through its strategic plan for West Africa (2017-2022). Gilson Semedo acknowledges the support given by the "Fundação para a Ciência e Tecnologia" (FCT) and "Instituto Gulbenkian de Ciência" (IGC) (Portugal, SFRH/BD/135266/2017). We are deeply thankful for the data on seabird occurrence provided by Biosfera (São Vicente Island), Project Biodiversity (Sal Island), Natura 2000 (Boavista Island), Bios CV (Boavista Island), Lantuna (Santiago Island) and Projecto Vitó (Fogo Island). This study benefitted also from funding by the strategic program of MARE, financed by FCT (UID/MAR/04292/2020), through national funds.

References

African Bird Club (2020) Working for birds and conservation in Africa: Cape Verde Islands: www.africanbirdclub.org

Anderson, O., Small, C., Croxall, J., Dunn, E., Sullivan, B., Yates, O. and Black, A. (2011) Global seabird bycatch in longline fisheries. *Endange. Species Res.* 14: 91–106

BirdLife International (2019) Important Bird Areas factsheet. Islets of Rombo. Obtained from http://www.birdlife.org

Bocage, J. V. (1902) Aves e répteis de Cabo Verde. *J. Sciencias Mathematicas Physicas e Naturaes* 6: 206–210.

Boessneckt, J. and Kinzelbach, R. (1993) Ein prähistorischer Brutplatz von Seevögeln auf der Insel Sal (Kapverden). *J. f. Ornithol.* 134: 245–271.

Bolle, C. (1856) Die Vogelwelt auf den Inseln des grünen Vorgebirges. *J. f. Ornithol.* 4: 17–31.

Bourne, W. R. (1955) *The birds of the Cape Verde Islands. Ibis* 97: 508–556.

Brooke, M. d., Bonnaud, E., Dilley, B. J., Flint, E. N., Holmes, N. D., Jones, H. P., Provost, P., Rocamora, G., Surman, C. and Buxton, R. T. (2017) Seabird population changes following mammal eradications on islands. *Anim. Conserv.* 21: 3–12.

Buxton, R. T. and Jones, I. L. (2011) Measuring nocturnal seabird activity and status using acoustic recording devices: applications for island restoration. *J. Field Ornithol.* 83: 47–60.

Caniato, B. J. (2006) Cabo Verde: a fome em sua literatura. *Veredas* 7: 131-14.

Clark, T. J., Matthiopoulos, J., Bonnet-Lebrun, A.-S., Campioni, L., Catry, P., Marengo, I., Poncet, S. and Wakefield, E. (2019) Integrating habitat and partial survey data to estimate the regional population of a globally declining seabird species, the sooty shearwater. *Global Ecol. Conserv.* 17: 1–15.

Croxall, J. P., Butchart, S. H. M., Lascelles, B., Stattersfield, A. J., Sullivan, B., Symes, A. and Taylor, P. (2012) Seabird conservation status, threats and priority actions: A global assessment. *Bird Conserv. Internatn.* 22: 1–34.

del Hoyo, J., Elliott, A., Sargatal, J., Christie, D. A. and Kirwan, G. (eds.) (2014) *Handbook of the birds of the world alive*. Barcelona: Lynx Edicions.

Dias, M. P., Martina, R., Pearmaina, E. J., Burfielda, I. J., Small, C., Richard and Croxall, J. P. (2019). Threats to seabirds: A global assessment. *Biol. Conserv.* 237: 525–537.

Dionis, S. M., Pérez, S. M., Hernández, P. A., Melián, G., Rodríguez, F., Padrón, E., Sumino, H., Barrancos, J., Padilla, G. D., Fernandes, P., Bandomo, Z., Silva, S., Pereira, J. M., Semedo, H. and Cabal, J. (2015) Diffuse CO_2 degassing and volcanic activity at Cape Verde islands, *West Africa*. Earth, Planets and Space 67: 1–15.

Doherty, T. S., Glen, S. A., Nimmo, D. G., Ritchie, E. G. and Dickman, C. R. (2016) Invasive predators and global biodiversity loss. *Proc. Natl. Ac. Sci. USA* 113: 11261–11265.

Frade, F. (1976) Aves do arquipélago de Cabo Verde (Coleção do Centro de Zoologia da J. I. C. V.). *Garcia de Orta, Série Zoologia* 5: 47–58.

Freitas, R., Romeiras, M., Silva, L., Cordeiro, R., Madeira P., González, J. A., Wirtz, P., Falcón, J. M., Brito, A., Floeter, S. R., Afonso, P., Porteiro, F., *et al.* (2019) Restructuring of the 'Macaronesia' biogeographic unit: A marine multi-taxon biogeographical approach. *Sci. Reports* 9: 1–19.

Furness, R. W. and Taske, M. L. (2000) Seabird-fishery interactions: quantifying the sensitivity of seabirds to reductions in sandeel abundance, and identification of key areas for sensitive seabirds in the North Sea. *Mar. Ecol. Progr. Ser.* 202: 253–264.

Gomes, N., Nevesa, R., Kenova, I. A., Campuzanoa, F. J. and Pinto, L. (2015) Tide and Tidal Currents in the Cape Verde Archipelago. *J. Integr. Coastal Zone Manage.* 15: 395–408.

Hazevoet, C. J. (1994) Status and conservation of seabirds in the Cape. *Birdlife Conservation Series* 1: 279–293.

Hazevoet, C. J. (1995) *The birds of the Cape Verde Islands*. Tring, UK: British Ornithologists Union. (BOU check List No. 13).

Hazevoet, C. J. (1996) Lista Vermelha para as Aves que nidificam em Cabo Verde. Pp. 128–135 in T. Leyens, and W. Lobin, eds. *Primeira Lista Vermelha de Cabo Verde*. Frankfurt, Germany: Forschungsinstitut Senckenberg.

Hazevoet, C. J. (2014) Eighth report on birds from the Cape Verde Islands, including records of nine taxa new to the archipelago. *Zool. Caboverdiana* 4: 29–56.

INE (2017) *Anuário Estatístico Cabo Verde 2017*. Santiago, Praia, Cabo Verde: Instituto Nacional de Estatística.

INE (2018) *Estatísticas do Ambiente –2016*. Cidade da Praia, Santiago, Cabo Verde: Instituto Nacional de Estatística.

Jones, C. W., Risi, M. M., Cleeland, J. and Ryan, P. G. (2019). First evidence of mouse attacks on adult albatrosses and petrels breeding on sub-Antarctic Marion and Gough Islands. *Polar Biol.* 42: 619–623.

Jones, H. P., Tershy, B. R., Zavaleta, E. S., Croll, D. A., Keitt, B. S., Finkelstein, M. E. and Howald, G. R. (2008) Severity of the effects of invasive rats on seabirds: A global review. *Conserv. Biol.* 22: 16–26.

Keulemans, v. J. (1866) Opmerkingen over de vogels van de Kaapverdische Eilanden en van Prins Eiland in de Bogt van Guinea gelegen. *Roy. Zool. Soc. Natura Artis Magistra, in Amsterdam* 3: 363–401.

Krüger, L., Paiva, V. H., Petry, M. V., Montene, R. C. and Ramos, J. A. (2018) Population estimate of Trindade Petrel *Pterodroma arminjoniana* by the use of predictive nest habitat modelling. *Bird Conserv. Internatn.* 28: 197–202.

Le Corre, M. (2008) Cats, rats and seabirds. *Nature* 451: 134–135.

Ledant (1988) in Hazevoet, C. J. (1995) *The birds of the Cape Verde Islands*. Tring, UK: British Ornithologists Union. (BOU check List No. 13).

Lopes, J. F., Ferreira, J. A. and Rocha, A. C. (2015) Circulação de correntes. P. 62 in R., Vasconcelos, A. C. Rocha, C. M. Afonso, C. Almeida, E. Lopes, I. C. Loura and J. A. Ferreira. *The natural history of the Desertas Islands*: *Santa Luzia Branco and Raso*. Global Environment Facility Small Grants Programme – Sociedade Caboverdiana de Zoologia.

Lopes, R. J., Pinho, C. J., Santos, B., Seguro, M., Mata, V. A., Egeter, B. and Vasconcelos, R. (2019) Intricate trophic links between threatened vertebrates confined to a small

island in the Atlantic Ocean. *Ecol. Evol.* 9: 4994–5002.

López-Suárez, P. (2012) Bird population monitoring report: Ospreys and Red-Billed Tropicbirds. ONG Cabo Verde Natura 2000.

López-Suárez, P., Hazevoet, C. J., and Palma, L. (2012) Has the magnificent frigatebird *Fregata magnificens* in the Cape Verde Islands reached the end of the road? *Zool. Caboverdiana* 3: 82–86.

López-Suárez P., Varo Cruz N., Hazevoet C. J. and López Jurado L. F. (2005) Restricted nesting habitat and reproductive failure of Magnificent Frigatebirds *Fregata magnificens* in the Cape Verde Islands. *Atlantic Seabirds* 7: 107–120.

Manne, L. L., Brooks, T. M. and Pimm, S. L. (1999) Relative risk of extinction of passerine birds on continents and Islands. *Nature* 399: 258–261.

MacGillivray (1852) in Hazevoet, C. J. (1995) *The birds of the Cape Verde Islands*. Tring, UK: British Ornithologists Union. (BOU check List No. 13).

Medina, F. M., Oliveira, P., Geraldes, P., Melo, J. and Barros, N. (2012) *Diet of feral cats Felis catus L., 1758 on Santa Luzia, Cape Verde Islands*. Zool. Caboverdiana 67–73.

Melo, J. (2011) Work done at the Marine Reserve of Santa Luzia, Cape Verde. P, 70 in Book of Abstracts. Ornithological Conference from the Portuguese Society for the Protection of Birds (SPEA).

Melo, J., Melo, J., Cabral, J. J. and Loura, I. C. (2015) Presença humana. Pp. 40-60 in R., Vasconcelos, A. C. Rocha, C. M. Afonso, C. Almeida, E. Lopes, I. C. Loura and J. A. Ferreira. *The natural history of the Desertas Islands*: *Santa Luzia Branco and Raso*. Ornithological Conference from the Portuguese Society for the Protection of Birds (SPEA).

Militão, T., Dinis, H. A., Zang, L., Calabuig, P., Stefan, L. M., and González-Solís, J. (2017) Population size, breeding biology and on-land threats of Cape Verde petrel (Pterodroma feae) in Fogo Island, Cape Verde. *PLoS ONE* 12(4): e0174803.

Millán, J. (2018) Feeding habits of feral cats *Felis silvestris catus* in the countryside of Majorca Island, *Spain*. Wildl. Biol. in Practice 6: 32–38.

Milne-Edwards, A. (1883) Description d'espéces nouvelles d'oiseaux provenant des Iles du Cap Vert. *Annales des Sciences Naturelles, Zoologie et Paléontologie* I-2.

Monteiro, L. R., Ramos, J. A. and Furness, R. W. (1996) Past and present status and conservation of the seabirds breeding in the Azores Archipelago. *Biol. Conserv.* 78: 319–328.

Monteiro, L. R., Ramos, J. A., Pereira, J. C., Monteiro, P. R., Feio, R. S., Bearhop, S. and Graz, M. P. (1999) Status and distribution of Fea's petrel, Bulwer´s petrel, Manx shearwater, Little shearwater and Band-rumped storm-petrel in the Azores Archipelago. *Waterbirds* 22: 358–366.

Murphy, R. C. (1924) The marine ornithology of the Cape Verde Islands, with a list of all the birds of the archipelago. *Bull. Am. Mus. Nat. Hist.* 50: 211–278.

Naurois, R. D. (1969) Notes brèves sur l'Archipel du Cap-Vert. Faunistique, endémisme, écologie. *Bull. Institut Fondamental d'Afrique Noire* 31: 143–218.

Naurois, R. D. (1970) *Muséum National d' Histoire naturelle*, Paris (France) Collection: Birds (ZO) Specimen MNHN-ZO-MO-1970-48. France museum data.

Nogales, M., Vidal, E., Medina, F. M., Bonnaud, E., Tershy, B. R., Campbell, K. J. and Zavaleta, E. S. (2013) Feral cats and biodiversity conservation: The urgent prioritization of island management. *BioScience* 63: 804–810.

Oliveira, N., Oliveira, J., Melo, T., Melo, J. and Geraldes, P. L. (2013) Possible breeding of Cape Verde storm-petrel Oceanodroma jabejabe (Bocage, 1875) on Santa Luzia, *Cape Verde Islands*. Zool. Caboverdiana 4: 17–20.

Paleczny, M., Hammill, E., Karpouzi, V. and Pauly, D. (2015) Population trend of the world's monitored seabirds, 1950-2010. *PLoS ONE* 10(6): e0129342.

Pina, A. F. (2010) *Passadores de Pau*. Praia: Author Edition.

Probst, J-M., Corre, M. Le and Thébaud, C. (2000) Breeding habitat and conservation priorities in *Pterodroma baraui*, an

endangered gadfly petrel of the Mascarene archipelago. *Biol. Conserv.* 93: 135–138.

R Core Team (2019) *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Ramalho, R., Helffrich, G., Schmidt, D. and Vance, D. (2010) Tracers of uplift and subsidence in the Cape Verde archipelago. *J. Geol. Soc.* 167: 519–538.

Rayner, M. J., Hauber, M. E. and Clout, M. N. (2007) Breeding habitat of the Cook's Petrel (*Pterodroma cookii*) on Little Barrier Island (Hauturu): implications for the conservation of a New Zealand endemic. *Emu - Austral Ornithol.* 107: 59–68.

Ratcliffe, N., Zino, F. J., Oliveira, P., Vasconcelos, A., Hazevoet, C. J., Neves, H. C., Monteiro R. L. and Zino, E. (2000) The status and distribution of Fea's Petrel *Pterodroma feae* in the Cape Verde islands. *Atlantic Seabirds* 2: 73–86.

Rendall, A. and Pile, E. (2007) *Plano de Conservação de Aves Marinhas para Cabo Verde.* Instituto Nacional de Investigação e Desenvolvimento Agrário (INIDA). Internal Report.

Riofrío-Lazo, M. and Páez-Rosas, D. (2015) Feeding habits of introduced black rats, *Rattus rattus*, in nesting colonies of Galapagos Petrel on San Cristóbal Island Galapagos. *PLoS ONE* 10(5): e0127901.

Rivas-Martínez, S., Lousã, M., Costa, J. C. and Duarte, M. C. (2017) Geobotanical survey of Cabo Verde Islands (West Africa). *Internatn. J. Geobotan. Res.* 7: 1–103.

Rodríguez, A., Rodríguez, B. and Lucas, M. (2012) Trends in numbers of petrels attracted to artificial lights suggest population declines in Tenerife, Canary Islands. *Ibis* 154: 167–172.

Rodríguez, A., García, D., Rodríguez, B., Cardona, E., Parpal, L. and Pons, P. (2015a) Artificial lights and seabirds: is light pollution a threat for the threatened Balearic petrels. *J. Ornithol.* 893–902.

Rodríguez, A., Rodríguez, B. and Negro, J. J. (2015b) GPS tracking for mapping seabird mortality induced by light pollution. *Sci. Reports* 5: 10670.

Romano, H., Fagundes, C. C., Zino, F. and Biscoito, M. (2010) Birds of the archipelagos of Madeira and the Selvagens. *Boletim do Museu Municipal do Funchal* 60 (326): 5–44.

Roque, A. C. and Torrão, M. M. (2013) Relação dos produtos naturais da Ilha do Fogo Remetidos na presente expedição para o Real Gabinete do Príncipe Nosso Senhor em 11 de Agosto de 1786. Pp. 60–73 in *Cabo Verde para Lisboa: Cartas e Remessas Científicas da Expedição Naturalista de João da Silva Feijo (1783-1796)*. Lisboa: Instituto de Investigação Cientifica Tropical.

Saavedra, C., Santos, M. B., Valcarce, P., Freitas, L., Silva, M., Pipa, T., *et al.* (2018) Macaronesian Roof Report. Technical Report. Macaronesia: Project MISTICSEAS II, 114. Available at: http://misticseas3.com/sites/default/files/material-divulgativo/macaronesian_roof_report_en.pdf.

Salvadori, T. (1899) Collezioni ornitologiche fatte nelle isole del Capo Verde do Leonardo Fea. *Annali del Museo Civico di Storia Naturale di Genova* 20: 283–312.

Santos, A. R. and Semedo, J. M. (2006) Subsídios para um plano de desenvolvimento integrado da ilha do Maio. Cidade de Praia, Cabo Verde: Instituto Superior de Educação.

Sarmento, R., Brito, D., Ladle, R. J., Leal, G. d. and Efe, M. A. (2014) Invasive house (*Rattus rattus*) and brown rats (*Rattus norvegicus*) threaten the viability of red-billed tropicbird (*Phaethon aethereus*) in Abrolhos National Park, Brazil. *Trop. Conserv. Sci.* 7: 614–627.

Simeone, A., Luna-Jorquera, G., Bernal, M., Garthe, S., Sepúlveda, F., Villablanca, R. and Ellenberg, U. (2003) Breeding distribution and abundance of seabirds on islands off north-central Chile. *Rev. Chilena Hist. Natural* 76: 323–333.

Tavares, A. and Ratão, S. S. (2017) *First monitoring of white-faced storm petrel* Pelogodroma marina *in Maio's island*, Cape Verde, West Africa. Fundação Maio Biodiversidade. http://www.seabirdgroup.org.uk/reports/grant-white-faced-storm-petrel-maio-island-2017.pdf.

Tosco, R. B., Castro, G. D. and Anderson, M. F. (2000) La Avifauna nidificante del Archipielago de Cabo Verde. *Makaronesia* 2: 43–55.

Vasconcelos, R., Rocha, A. C., Afonso, C. M., Almeida, C., Lopes, E., Loura, I. C. and Ferreira, J. A. (2015) *The natural history of Desertas Islands: Santa Luzia, Branco e Raso*. CIBIO-InBIO (Universidade do Porto); IICT (Jardim Botânico Tropical de Portugal); DECM (Universidade de Cabo Verde).

Venables, W. N. and Ripley, B. D. (2002) *Modern applied statistics with S*. Fourth Edition. New York: Springer.

Xu, L., Liu, X., Wu, L., Sun, L., Zhao, J. and Chen, L. (2016) Decline of recent seabirds inferred from a composite 1000-year record of population dynamics. *Sci. Reports* 6: 35191.

Supplementary Material

Distribution, abundance, and on-land threats to Cabo Verde seabirds

GILSON SEMEDO, VITOR H. PAIVA, TERESA MILITÃO, ISABEL RODRIGUES, HERCULANO A. DINIS, JORGE PEREIRA, DIANA MATOS, FILIPE R. CEIA, NATHALIE M. ALMEIDA, PEDRO GERALDES, SARAH SALDANHA, NADITO BARBOSA, MARCOS HERNÁNDEZ-MONTERO, CAROLINO FERNANDES, JACOB GONZÁLEZ-SÓLIS and JAIME A. RAMOS

Contents

Table S1. Historical records used to elaborate maps of the past and current seabird destruction in Cabo Verde archipelago. 1) Past distribution (information from historical expeditions, museums, grey and scientific literature until 1995) and 2) Current distribution (records after 1995).

1) Past distribution of seabirds						
Year	**Expedition/Study**	**Areas**	**Species**	**Breeding confirmation (Yes, No)**	**Qualitative abundance/ trends**	**Reference**
1783 - 1796	Expedition of João da Silva Feijó in Cabo Verde. Visual observations	Fogo Island	*Sula Ieucogaster*	No	No Information	Roque & Torrão (2013)
1852 - 1856	Reference to areas of occurrence of birds in the Cabo Verde archipelago. Visual observations	Brava Island, Raso and Branco Islets	*Calonectris edwardsii*	No	No Information	Bolle (1856)
		Raso Islet	*Bulweria bulwerii*	No	No Information	
		Branco Islet	*Pelagodroma marina aedesorum*	No	No Information	
		Santiago Island (Porto da Praia), Rabo de Junco (Sal) Islet	*Phaethon aethereus*	No	No Information	
		Santiago (Ponta de Alcatraz), Brava, Fogo Islands and Rombo Islets	*Sula Ieucogaster*	No	No Information	
		Islet of Pássaros (São Vicente)	*Fragata magnificens*	No	No Information	
1865	Ornithological observation on the islands of Santo Antão, São Vicente, São Nicolau and Santiago.	Santiago Island	*Phaethon aethereus*	No	No Information	Keulemans (1866)
		Santo Antão, São Nicolau Islands, Islet of Pássaros (São Vicente)	*Fragata magnificens*	No	Main population of the archipelago in the islet Pássaros	

1883	Milne-Edwards, Alphons expedition in the Cabo Verde Island. Material collected: seabirds	Branco Islet	*Calonectris edwardsii*	No	No Information	MNHN – Paris (2018)
1884	Talisman Expedition the Cabo Verde Island. Material collected: seabird	Branco Islet (16° 39' 33.1812" N; 24° 40' 15.6036" O)	*Calonectris edwardsii*	No	No Information	MNHN – Paris (2018)
1898	Exploration of birds and reptiles in the archipelago. List of species contributed by Francisco Newton,	Brava Island and Raso Islet	*Calonectris edwardsii*	No	No Information	Bocage (1902)
		Raso Islet	*Bulweria bulwerii*	No	No Information	
		São Nicolau Island	*Pterodromo feae*	No	No Information	
	Boyd Alexander and Leonardo Fea. List of birds and reptiles found in Cabo Verde.					
1912 - 1922	Ornithological observation on the Cabo Verde Island; The systematic list of the birds of the archipelago based on the writings of Bocage, Bolle, Dohrn, Keulemans, and Salvadori.	Brava Island, Rombo and Branco Islets	*Calonectris edwardsii*	Yes	Most abundant population in Raso Islet (Correia)	Murphy, 1924
		Rombo (Cima) and Raso Islets	*Bulweria bulwerii*	Yes	No Information	
		São Nicolau and Brava Islands, Branco, Raso, Branco and Rombo (Cima) Islets	*Hydrobates jabejabe*	Yes	No Information	
		Branco and Rombo Islets	*Pelagodroma marina aedesorum*	Yes	Eighteen individuals	

					at Cima (Correia)	
		São Antão[1], São Nicolau and Fogo Islands	*Pterodromo feae*	yes	*Many flocks[1]*	
		Fogo, Santiago Islands, Raso, Branco and Rombo (Cima) Islets	*Puffinus lherminieri boydi*	Yes	No Information	
		São Vicente, Sal, Boavista, Santiago Islands, Raso and Rombo Islets	*Phaethon aethereus*	Yes	Breeding in small numbers in suitable holes and clefts	
		São Antão, São Vicente, São Nicolau, Sal, Santiago and Brava Islands, Rombo and Raso Islets	*Sula Ieucogaster*	Yes	There are thousands	
		São Antão[2], São Vicente[2], São Nicolau[2] and Santiago islands[2], Sal Rei (Boavista) Islet[1]	*Fragata magnificens*	1-Yes 2-No	No Information	
1951	Ornithology observations d in the Cabo Verde Islands. Ornithological observations and report from other Researchers (e.g Bannerman 1930-51, Murphy, 1924)	Brava[1], Santiago[2] Islands, Raso[1] Islet	*Calonectris edwardsii*	1-Yes 2-No	No Information	Bourne (1955)
		Raso and Rombo (Cima) Islets	*Bulweria bulwerii*	Yes	No Information	
		Santo Antão[2], São Nicolau[2], Santiago Islands[2], Raso[1], Branco[1] and Rombo (Cima) Islets[1]	*Hydrobates jabejaba*	1-Yes 2-No	No Information	

		Branco and Rombo (Cima) Islets	*Pelagodroma marina aedesorum*	Yes	No Information	
		São Antão (Ribeira Grande), São Nicolau (Ribeira Brava), Santiago (São Domingos, Orgãos, Picos, Serra Malagueta, Santa Ana) and Fogo Islands	*Pterodromo feae*	Yes	No Information	
		Santo Antão[2], São Vicente[2], São Nicolau[2], Sal[2], Boavista2, Brava[1] Raso[1] and Rombo (Cima)[1] Islets	*Puffinus lherminieri boydi*	1-Yes 2- No	Several dozen birds visited Cima after dark on 28-30 August	
		São Antão, São Vicente, São Nicolau, Sal, Boavista, Santiago, Fogo and Brava Islands, Raso, Branco, Rombo (Cima and Grande) Islets	*Phaethon aethereus*	Yes	≤1000 pairs	
		São Antão, São Vicente, São Nicolau, Sal, Boavista, Santiago (Baia do Inferno), Brava Islands, Rombo (Cima) and Raso Islets	*Sula Ieucogaster*	Yes	≤1000 pairs	
		São Antão[2], São Vicente[2], São Nicolau[2], Sal[1], Santiago[2] and Boavista Islands[1]	*Fragata magnificens*	1-Yes 2-No	No Information	
1963		Rombo Islets (Cima)	*Bulweria bulwerii*	No	No Information	

	René de Naurois, expedition in the Cabo Verde Island. Material collected: seabird.	14° 58' 0.012" N; 24° 40' 0.012" O	*Hydrobates jabejaba*	No	No Information	MNHN – Paris (2018)
		Rombo (Cima) and Raso Islets	*Puffinus lherminieri boydi*	No	No Information	
1961 -1965	Exploration in the Cabo Verde about avifauna, endemisms and ecology.	Santo Antão[1], Brava[1] Islands, Branco[1], Raso[1], Curral Velho[2] Islets (Boavista)	*Calonectris edwardsii*	1-Yes 2-No	Several thousand pairs	Naurois (1969)
		Rombo Islets (Cima)	*Bulweria bulwerii*	Yes	Dozens of pairs	
		Rombo[1], Branco[1], Raso[2] and Pássaros[1] Islets (Boavista)	*Hydrobates jabejabe*	1-Yes 2- No	*Hydrobates jabejaba* populations are with those of Pelagodroma in a ratio of 1 to 100 (or less)	
		Rombo, Laje Branca (Maio), Pássaros (Boavista) Islets	*Pelagodroma marina aedesorum*	Yes	No Information	
		São Antão (Alto Mira and Paúl), Santiago, Fogo (Chã das Caldeiras) Islands	*Pterodromo feae*	Yes	No Information	
		Santiago Island (in the center, 15 km from the sea and 500 m altitude), Branco, Rombo, Raso, Curral Velho (Boavista) Islets	*Puffinus lherminieri boydi*	Yes	Few thousand	
		Boavista, Santiago, Brava Islands, Rombo, Rabo de Junco (Sal) Islets	*Phaethon aethereus*	Yes	< 1.000	

		São Vicente, Santiago (Baía de Inferno), Fogo, Sal, Brava Islands, Rombo, Curral Velho, Baluarte (Boavista) and Raso Islets	*Sula Ieucogaster*	Yes	< 2.000 birds	
		Curral Velho, Baluarte (Boavista) Islets	*Fragata magnificens*	Yes	10 – 12 pairs	
1970	René de Naurois, expedition in the Cabo Verde Island. Material collected: seabirds	Raso (16° 37' 6.6" N; 24° 35' 9.6" O) and Branco Islets	*Bulweria bulwerii*	No	No Information	MNHN – Paris (2018)
		Branco Islet (16° 39' 33.1812" N; 24° 40' 15.6036" O)	*Hydrobates jabejabe*	No	No Information	
1969, 1970 and 1972	Systematic catalogue report the ornithological material collected in Cabo Verde Island, during the prospections made by Zoological Centre of Lisbon. For each species mentions are made by the scientific and the vernacular name, registration number, the sex, threats in the archipelago and reproduction period of species. Material collected: seabirds	São Antão, Brava Islands, Branco, Raso and Curral Velho (Boavista) Islets	*Calonectris edwardsii*	Yes	No Information	Frade (1976)
		Branco, Raso, Pássaros (Boavista) and Rombo Islets	*Hydrobates jabejabe*	Yes	No Information	
		Branco, Pássaros (Boavista), Rombo (Grande and Cima), Laje Branca (north of the Island of Maio) Islets	*Pelagodroma marina aedesorum*	Yes	No Information	
		Santiago Island, Rombo, Branco, Raso and Curral Velho (Boavista) Islets	*Puffinus lherminieri boydi*	Yes	No Information	
		Boavista, Santiago, Brava Islands, Rabo de	*Phaethon aethereus*	Yes	No Information	

		Junco (Sal) and Rombo Islets				
		São Vicente, Santiago, Fogo Islands, Raso, Curral Velho (Boavista) and Rombo Islets	*Sula Ieucogaster*	Yes	No Information	
22 November, 1986 till 15 February, 1987.	Ornithological observations in Cabo Verde Island	Santiago (Praia) Island	*Phaethon aethereus*	No	No Information	Bruyn & Koedijk (1990)
		Santo Antão, Sal, Boavista, Maio, Santiago, Fogo, Brava, Vicente (between Salamansa and Baia das Gatas) and São Nicolau Islands	*Sula Ieucogaster*	No	No Information	
		Boavista and Maio (Ponta Banconi) Islands	*Fragata magnificens*	No	No Information	
1990	Analysis of seabird fossils found on the island of Sal.	Sal Island	*Calonectris edwardsii*	No	No Information	Boessneck & Kinzelbach (1993)
		Sal Island	*Pelagodroma marina aedesorum*	No	No Information	
		Sal Island	*Puffinus lherminieri boydi*	No	No Information	
		Sal Island	*Sula Ieucogaster*	No	No Information	
		Sal Island	*Fragata magnificens*	No	No Information	
1986 - 1992	Reviews existing information on the seabirds of the Cabo Verde Islands. Presents new survey data for each breeding species, identifies past and present population sizes	Santo Antão[1], São Nicolau[1], Sal[2], Santiago[1] and Brava[1] Islands, Raso[1], Branco[1] and Curral Velho[1] (Boavista) Islets	*Calonectris edwardsii*	1-Yes 2-No	10.000 pairs	Hazevoet (1994)
		Rombo (Cima) and Raso Islets	*Bulweria bulwerii*	Yes	100 pairs	

	and current trends, and outlines a management plan for the conservation and protection of the seabird community.	São Antão[2], Santiago[2] and Brava[2] Islands, Branco[1], Raso[1], Curral Velho[1], Pássaros[1] (Boavista) and Rombo (Luiz Carneiro[1] and Cima[1]) Islets	*Hydrobates jabejabe*	1-Yes 2-No	>1000 pairs	
		Branco[1], Pássaros[2], Rombo (Cima)[1] and Laje Branca[1] Islets (Maio)	*Pelagodroma marina aedesorum*	1-Yes 2-No	< 10.000 pairs	
		São Antão (Ribeira Grande, Alto Mira, Paúl), São Nicolau (Monte Cintenha), Santiago (Lagoa de São Domingos, Monte Pico de António, Órgãos) Fogo (Chã das Caldeiras) Islands	*Pterodromo feae*	Yes	500 pairs	
		São Antão (Ribeira Grande[2]), São Vicente, São Nicolau, Santiago, Fogo and Branco Islands, Raso, Curral Velho (Boavista) and Rombo (Cima) Islets	*Puffinus lherminieri boydi*	1-Yes 2-No	5.000 pairs	
		Sal[1], Boavista[1], Santiago[1], Brava[2] Islands, Rombo (Cima[1] and Luiz Carneiro[2]), Raso[1] Islets	*Phaethon aethereus*	1-Yes 2-No	< 100 pairs	
		São Antão[2], São Vicente[1], Sal[1], Boavista[2], Santiago[1], Brava[1]	*Sula Ieucogaster*	1-Yes 2-No	750 pairs	

		Islands, Raso[1], Baluate[1] and Curral Velho[1] (Boavista), Rombo Islets (Cima[1] and Luiz Carneiro[2])				
		Curral Velho and Beluarte (Boavista) Islets	*Fragata magnificens*	Yes	5 pairs	
1988 - 1993	Book about distribution, population size and threats that seabirds suffer in the Cabo Verde Islands. Visual observations, reports from previous researchers and ornithologists (e.g. Macgillivray, 1852; Keulemans, 1866; Alexander, 1898; Ledant, 1988).	Santo Antão, São Nicolau (Ponta Tapadinho and Fundu de Dagu), Sal, Santiago (Porto Rincão and Ribeira da Barca), Brava Islands, Branco, Raso, Rabo de Junco, Curral Velho (Boavista) Islets	*Calonectris edwardsii*	Yes	Several thousand pairs	Hazevoet (1995)
		Raso and Rombo (Cima) Islets	*Bulweria bulwerii*	Yes	≤ 100 pairs	
		Santo Antão[2], Santiago[2], along the coast of Brava[1] and São Nicolau[1] Islands, Rombo (Cima[1], Luís Carneiro[1]), Branco[1] and Raso[1], Laje Branca[2] Islets	*Hydrobates jabejabe*	1-Yes 2-No	≤ 1.000 pairs	
		Sal Island (subfossil) Rombo (Grande and Cima), Branco, Pássaros (Boavista), Laje Branca (Maio) Islets	*Pelagodroma marina aedesorum*	Yes	5.000 - 10.000 pairs	

		Santiago (Monte Pico António, Santa Ana, São Domingos, Órgão, Rui Vaz, Lagoa de São Domingos), Fogo (Chã das Caldeiras), Santo Antão (Ribeira Grande, Alto Mira, Paúl) and São Nicolau (Montanha de Fajã, Monte Gordo) Islands	*Pterodromo feae*	Yes	500 -1.000 pairs	
		Santiago (Santa Cruz, São Jorge dos Órgãos)[1], Fogo[2], Brava, Santo Antão (Ribeira grande)[2], São Vicente (Monte Verde)[2], São Nicolau Islands (Ribeira Brava, montanha de Fajã and Fragata)[2], Curral Velho[1] (Boavista), Rombo (Cima)[1], Raso[1] and Branco[1] Islets	*Puffinus lherminieri boydi*	1-Yes 2-No	Several thousand pairs	
		Santiago (Praia, Porto Mosquito and Baia do Inferno) and Brava Islands, Rombo (Cima and Luiz Carneiro), Raso, (Curral Velho (Boavista) and Rabo de Junco (Sal) Islets	*Phaethon aethereus*	Yes	100 -125 pairs	
		Santo Antão (Monte Trigo)[2], Santiago (Baía do Inferno)[1], Fogo[2],	*Sula Ieucogaster*	1-Yes 2-No	≤ 1.000 pairs	

		Brava Islands (Furna, Porto dos Ferreiros)[1], Rombo (Cima and Luís Carneiro)[1], Baluarte[1] (Boavista), Pássaros[2] (São Vicente), Rabo de Junco (Sal) Islets[1]				
		Curral Velho[1], Baluarte[1] and Sal Rei[2] (Boavista) Islets	*Fragata magnificens*	1-Yes 2-No	≤ 5 pairs	

2) Current distribution of seabirds						
Year	**Expedition/Study**	**Areas**	**Species**	**Breeding confirmation (Yes, No)**	**Qualitative abundance/ trends**	**Reference**
1996	Report about ornithological observations in the Cabo Verde Islands.	Ponta do Sol	*Calonectris edwardsii*	No	Ponta do Sol > 100	Hazevoet (1997)
		Raso and Rombo Islets (Cima)	*Bulweria bulwerii*	Yes	≤ 100 pairs	
		Santo Antão (Ribeira Grande, Ponta do Sol), São Nicolau (Estancia Bras) Islands	*Pterodroma feae*	Yes	Ribeira Grande > 100; Ponta do Sol 20; Estância Bras >10	
		Sal (Ponta Fragata), Boavista (Ponta do Sol), Santiago Islands (Praia), Rabo de Junco (Sal), Raso Islets	*Phaethon aethereus*	Yes	≤100 pairs	
		Raso, Rabo de Junco (Sal) Islets	*Sula Ieucogaster*	Yes	150 - 200 birds	
		Boavista Island	*Fragata magnificens*	Yes	5 pairs	

1997	Bird watching on the Cabo Verde	Raso Islet	*Bulweria bulwerii*	Yes	3 birds (July 31)	Geniez & Lopez-Jurado (1998)
		Raso Islet	*Hydrobates jabejabe*	Yes	2 bird (September 25)	
		Raso Islet	*Phaethon aethereus*	Yes	8 pairs (July 31 and September 26)	
		Near of Sal Rei (Boavista)	*Fragata magnificens*	No	1 bird flying (July 11-18)	
1999	Report about ornithological observations in the Cabo Verde Islands. Report from visual observations and from other researchers and ornithologists (e.g. Clifford 'Bud' Anderson, Rubén Barone, Tony Clarke, Kris De Rouck, Tim Dodman, Hugues Dufourny).	Santo Antão (Ponta do Sol, Vila da Ribeira Grande), São Nicolau, Santiago and Fogo islands	*Pferodrorna feae*	Yes	Ponta do Sol 50-300 (25 and 26 February); Vila da Ribeira Grande 140 (27 February). 40 and c. 20 off Ponta do Sol (12 and 13 March)	Hazevoet (1999)
		Boavista (Ponta Rincão and north of Sal Rei), Curral Velho Islet	*Phaethon aefhereus*	No	140 – 160 pairs	
1999	Ornithological observations in the Cabo Verde Islands.	Curral Velho (Boavista) Islet	*Phaethon aefhereus*	Yes	No Information	Dufourny (1999)
		Curral Velho (Boavista) Islet	*Sula Ieucogaster*	Yes	No Information	
		Curral Velho (Boavista) Islet	*Fragata magnificens*	No	No Information	
April 1999	Ornithological observations in Cabo Verde (Santo Antão, São Vicente, São Nicolau, Sal and Boavista).	Santo Antão (Ribeira Grande[2]), São Vicente[2], São Nicolau[1], Boavista[1], Santiago[1], Brava[1] Islands, Rabo de Junco (Sal)[1],	*Calonectris edwardsii*	1-Yes 2- No	10.000 couple. Observation of 35 birds at sea	Tosco *et al.,* (1999)

		Branco[1], Raso[1] Islets			between Santo Antão and São Vicente.	
		Santo Antão[2], São Vicente[2], Santiago[1] and Boavista[1] Islands, Branco[1], Raso[1] Islets.	*Puffinus lherminieri boydi*	1- Yes 2- No	1 bird observation	
		São Nicolau Island[2], Raso Islets[1]	*Sula Ieucogaster*	1-Yes 2- No	125 pairs. 1 bird fly near São Nicolau	
2000	Census of Fea's Petrel in the Cabo Verde Islands. Counts of nocturnal calls	Santo Antão (Ribeira Grande, Fajã dos Cumes, Ribeira da Torre, Ribeira do Paúl, Ribeira Fria, Escabeçada, Alto Mira, Chã do Norte, Carvoeirinho, Topo Biôro), São Nicolau (Monte Deserto, Monte Sentinho, Ribeira Funda and Ribeira da Covoada), Santiago and Fogo (Topo, Cabeça Turil, Chã das Caldeiras) Islands	*Pterodroma feae*	Yes	Santo Antão (200 pairs), São Nicolau (30 pairs) and Fogo Islands (80 pairs)	Ratcliffe *et al.,* (2000)
1999	Review of breeding birds in Cabo Verde Based on the work Hazevoet (1995, 1996, 1997, 1998, and 1999) and author's Ornithological observation on the	Santo Antão, São Nicolau, Sal, Boavista, Santiago and Brava Island, Raso and Branco Islets	*Calonectris edwardsii*	Yes	<10.000 pairs	Tosco *et al.,* (2000)
		Rombo (Cima) and Raso Islets	*Bulweria bulwerii*	Yes	>100 pairs	

	Cabo Verde Islands.	Branco, Raso, Pássaros, Curral Velho (Boavista) and Rombo Islets.	*Hydrobates jabejabe*	Yes	Over around a thousand	
		Branco, Pássaros (Boavista), Laje Branca (Maio) and Rombo Islets.	*Pelagodroma marina aedesorum*	Yes	5.000 - 10.000 pairs	
		Santo Antão, São Nicolau, Santiago and Fogo Islands	*Pterodromo feae*	Yes	No Information	
		Main islands except Sal and Maio Islands	*Puffinus lherminieri boydi*	Yes	No Information	
		Sal, Boavista, Santiago, Brava Islands, Raso and Rombo Islets	*Phaethon aethereus*	Yes	125 pairs	
		Main islands and islets except Santo Antão, São Vicente, São Nicolau, Maio and Fogo Islands	*Sula Ieucogaster*	Yes	1.000 pairs	
		Curral Velho and Baluarte Isets	*Fragata magnificens*	Yes	5 pairs	
1999-2002	Ornithological observations in the Cabo Verde Islands.	Santo Antão (small colony along the coast, 3 km north of Tarrafal) Island	*Phaethon aethereus*	No	10 pairs	Hazevoet (2003)
1999 up to May 2006	Report about nesting habitat and reproductive failure of Magnificent Frigatebirds in the Cabo Verde Islands. Monitored from the summer of	Baluarte and Curral Velho (Boavista) Islets	*Fragata magnificens*	Yes	4-5 birds	Suárez *et al.,* (2005)

	1999 up to May 2006.					
July 2005	Report about systematic sea watching and counting of Cabo Verde Shearwaters in the period 20-27 July 2005. Largest numbers were counted 2-2.5 hours before sunset. Main flight direction was east.	Santo Antão (Ponta do Sol, 17º12'00"N, 25º05'23"W) Island	*Calonectris edwardsii*	No	6.653 birds	Horssen (2006)
2008 - 2012	Short note about occurrence the *Fregata magnificens* in the Cabo Verde Islands.	Curral Velho and Baluarte (Boavista) Islets	*Fragata magnificens*	No	1-3 birds	Suárez *et al.,* (2012)
2012	Short note about possible breeding of Cape Verde storm-petrel on Santa Luzia.	Santiago (Baía do Inferno Baía) and Santa Luzia Islands	*Hydrobates jabejabe*	No	No Information	Oliveira *et al.,* (2013)
2012-2014	Data on status and distribution of resident and migrant birds in the Cabo Verde Islands.	Curral Velho (Boavista) Islet	*Fragata magnificens*	No	3 birds	Hazevoet (2014)
2015	Book about the Geology, Geography, Human Presence, Oceanography, Marine Biodiversity, Vegetation, Terrestrial reptiles, and breeding birds, Of Desertas (Santa Luzia Island, Razo Islet, Branco Islet)	Raso and Branco Islets	*Calonectris edwardsii*	Yes	No information	Hazevoet (2015)
		Raso and Branco Islets	*Bulweria bulwerii*	Yes	No Information	
		Santa Luzia Island[2], Raso and Branco Islets[1]	*Hydrobates jabejabe*	1-Yes 2- No	No Information	
		Branco Islet	*Pelagodroma marina aedesorum*	Yes	No Information	
		Raso and Branco Islets	*Puffinus lherminieri boydi*	Yes	No Information	

		Raso Islet	*Phaethon aethereus*	Yes	No Information	
		Raso Islet	*Sula Ieucogaster*	Yes	No Information	
August to December 2016	Population census, distribution and biometric measurements of *Phaethon aethereus* in the Raso islet	Raso Islet	*Phaeton aethereus*	Yes	100 pairs	Santos *et al.,* (2017)
2016	Onithological report about possible breeding sites of the Red-billed tropicbird *Phaeton aethereus* and the Brown booby *Sula leucogaster* on São Nicolau Island.	São Nicolau (Ponta Barroso) Island	*Phaeton aethereus*	No	18 birds (São Nicolau)	Martins *et al.,* 2017
		São Nicolau (Baía da Chacina) Island	*Sula Ieucogaster*	No	1 bird (São Nicolau)	
2007 - 2016	Scientific report about population size, breeding biology and threats on land. Population size based on capture-mark-recapture using mist-nets.	Fogo (Chã das Caldeiras, Bordeira, Monte Preto, Achada Grande - Mosteiros and Fernão Gomes-Monte Velha) Island	*Pterodroma feae*	Yes	293 birds	Militão *et al.,* 2017

Note: The number one (1) areas with confirmed reproduction of seabirds and two (2) areas that have not been confirmed reproduction of seabirds.

References

Bocage, J. V. (1902) Aves e répteis de Cabo Verde. *Journal Sciencias Mathematicas Physicas E Naturaes, 6*: 206-210.

Boessneck, J., and Kinzelbach, R. (1993) Ein prähistorischer Brutplatz von Seevögeln auf der Insel Sal (Kapverden). *Journal Fur Ornithologie, 134*: 245-271.

Bolle, C. (1856) Die Vogelwelt auf den InseLn des grünen Vorgebirges. *Journal fur Ornithogie, 4*: 17-31.

Bourne, W. R. (1955) The Birds of the Cape Verde Islands. *Ibis, 97*: 508-556.

Bruyn, D. D., and Koedijk, O. (1990) Bird watching during the Great Drought on the Cape Verde Islands. *Courier Forschungsinst Senckenberg, 129*: 191-196

Dufourny, H. (1999) White-tailed Tropicbird in Cape Verde Islands in February 1999. *Dutch Birding 21*: 254-255.

Frade, F. (1976) Aves do arquipélago de Cabo Verde (Coleção do Centro de Zoologia da J. I. C. V.). *Garcia de Orta, Série Zoologia, 5*: 47-58.

Geniez, P., and Lopez-Jurado, L. F. (1998) Nouvelles observations ornithologiques aux iles du CapVert. *Alauda, 66*: 307-311.

Hazevoet, C. J. (1994) Status and conservation of seabirds in the Cabo Verde Islands. *BirdLife Conservation Series*, 279-293.

Hazevoet, C. J. (1995) *The Birds of the Cape Verde Islands. Check-list No. 13*. British Ornithologists' Union, Tring.

Hazevoet, C. J. (1997) Notes on distribution, conservation, and taxonomy of birds from the Cape Verde Islands, including records of six species new to the archipelago. *Bulletin Zoologisch Museum, 15:* 89-100.

Hazevoet, C. J. (1999) Fourth report on birds from the Cape Verde Islands, including notes on conservation and records of 11 taxa new to the Archipeiago. *Bulletin Zoologisch Museum, 17*: 19-32.

Hazevoet, C. J. (2003) Fifth report on Birds From The Cabo Verde Islands, including Records of 15 Taxa New to the Archipelago. *Arquivos do Museu Bocage, 3*: 503-528.

Hazevoet, C. J. (2014) Eighth report on birds from the Cape Verde Islands, including records of nine taxa new to the archipelago. *Zoologia Caboverdiana, 4*: 29-56.

Hazevoet, C. J. (2015) Breeding birds. Obtained from Vasconcelos, R., Rocha, A. C., Afonso, C. M., Almeida, C., Lopes, E., Loura, I. C., Ferreira, J. A. (2015), The Natural History of the Desertas Islands: Santa Luzia, Branco and Raso.

Horssen, P. V. (2006) Large Numbers of Cape Verde Shearwaters Calonectris edwardsii off Santo Antão, Cape Verde Island, In July 2005. *Atlantic Seabirds, 7*: 121-126.

Keulemans, v. J. (1866) Opmerkingen over de vogels van de Kaapverdische Eilanden en van Prins Eiland in de Bogt van Guinea gelegen. *Royal Zoological Society Natura Artis Magistra, in Amsterdam, 3*: 363 - 401.

Martins, S., Fortes, R., and Palma, L. (2017) New Beeding sites of the Red-billed tropicbird Phaeton aethereus and the Brown booby Sula leucogaster on São Nicolau Island, Cabo Verde. *Zoologia Caboverdiana, 6*: 5-8.

López-Suárez P., Varo Cruz N., Hazevoet C.J. & López Jurado L.F. (2005) Restricted nesting habitat and reproductive failure of Magnificent Frigatebirds *Fregata magnificens* in the Cape Verde Islands. *Atlantic Seabirds 7(*3): 107-120.

Militão, T., Dinis, H. A., Zang, L., Calabuig, P., Stefan, L. M., and González-Solís, J. (2017) Population size, breeding biology and on-land threats of Cape Verde petrel (Pterodroma feae) in Fogo Island, Cape Verde. *PLoS ONE, 12*: 1-20.

MNHN. (2018) Data from the National Museum of Natural History, Paris (France) Collection: Birds (ZO) Specimen MNHN-ZO-MO-1970-48. *The birds collection (ZO) of the Muséum national d'Histoire Naturelle (MNHN - Paris)*. Paris, França.

Murphy, R. C. (1924) The Marine Ornithology of the Cape Verde Islands, with a List of all the Birds of the Archipelago. *Bulletin American Museum of Natural History, 50*: 211-278.

Naurois, R. D. (1969) Notes brèves sur l'Archipel du Cap-Vert. Faunistique, endémisme, écologie. *Bulletin de l'Institut Fondamental d'Afrique Noire, 31*: 143-218.

Norrevang, A. and Hartog, J. C. (1984) Birds observations in the Cape Verde Islands (4-22 June 1982). Courier Forschungsinst Senckenberg, 107-134.

Oliveira, N., Oliveira, J., Melo, T., Melo, J., and Geraldes, P. L. (2013) Possible breeding of Cape Verde storm-petrel Oceanodroma jabejabe (Bocage, 1875) on Santa Luzia, Cape Verde Islands. *Zoologia Caboverdiana, 4*: 17-20.

Ratcliffe, N., Zino, F. J., Oliveira, P., Vasconcelos, A., Hazevoet, C. J., Neves, H. C., Monteiro, L. R., Zino, E. A. (2000) The status and distribution of Fea's pretel Pterodroma feae in the Cape Verde islands. *Atlantic Seabirds, 2*: 73-86.

Roque, A. C. and Torrão, M. M. (2013) Relação dos produtos naturais da Ilha do Fogo Remetidos na presente expedição para o Real Gabinete do Príncipe Nosso Senhor em 11 de Agosto de 1786. Obtained from Cabo Verde para Lisboa: Cartas e Remessas Cientificas da Expedição Naturalista de João da Silva Feijo (1783 - 1796) (pp. 60 -73). Lisboa: Instituto de Investigação Cientifica Tropical.

Santos, K., Brás, N., Rodrigues, I., and Santos, M. d. (2017) Analysis of population size and distribution of Phaeton aethereus (Linnaeus, 1758) on Raso Islet, Cabo Verde. *Zoologia Caboverdiana, 6*: 25-31.

Suárez, P. L., Hazevoet, C. J., and Palma, L. (2012) Has the Magnificent frigatebird Fregata magnificens in the Cabo Verde Islands reached the end of the road? *Zoologia Caboverdiana, 3*: 82-86.

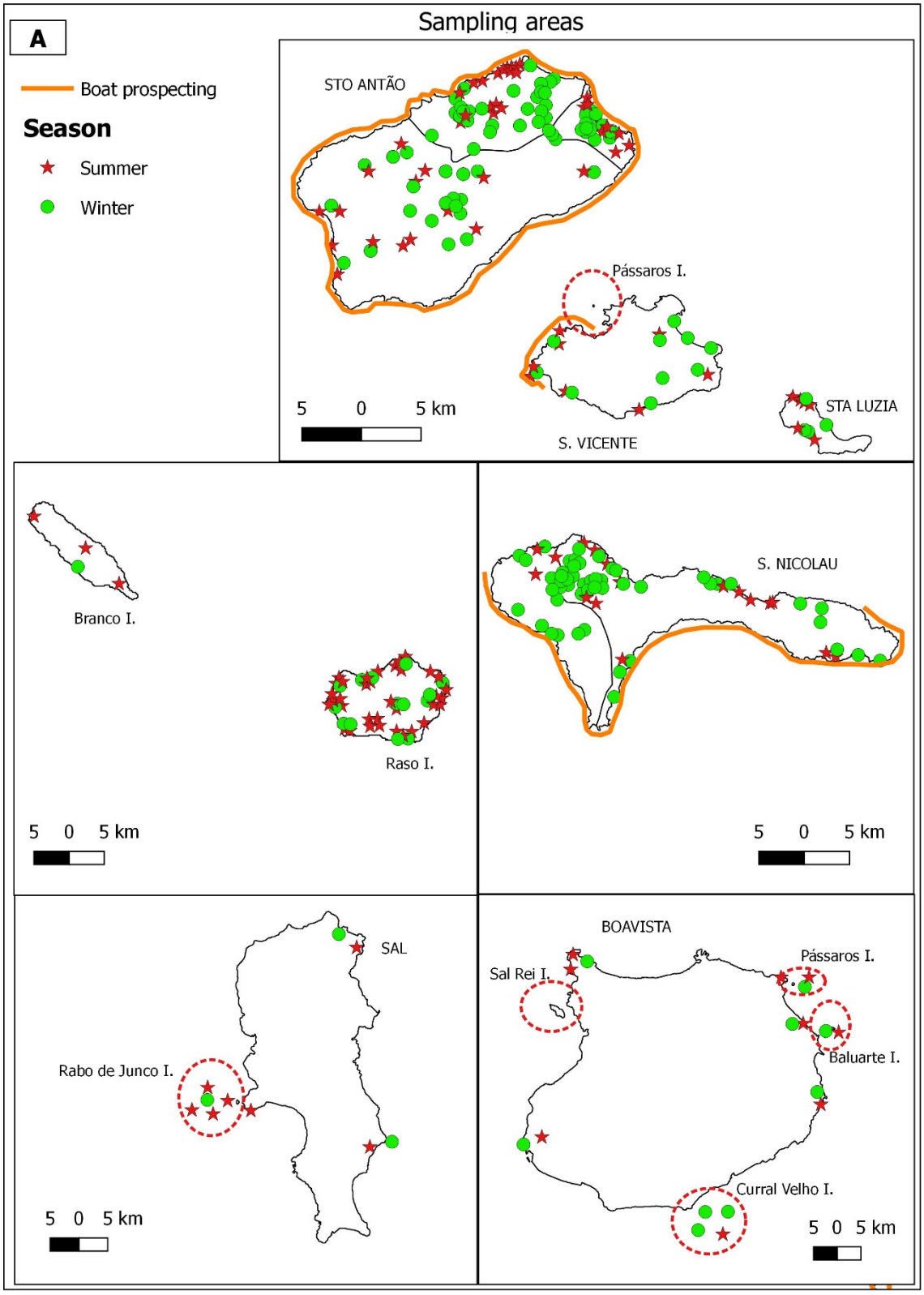
Tosco, R. B., Castillo, M. F., and Bacallado, J. (1999) Nueva Contribucion a La Ornitologia de Cabo Verde. Observaciones de Interes en Las Islas de Barlovento, Abril de 1999. *Revista de la Academia Canaria de Ciencias, 11*: 173-187.

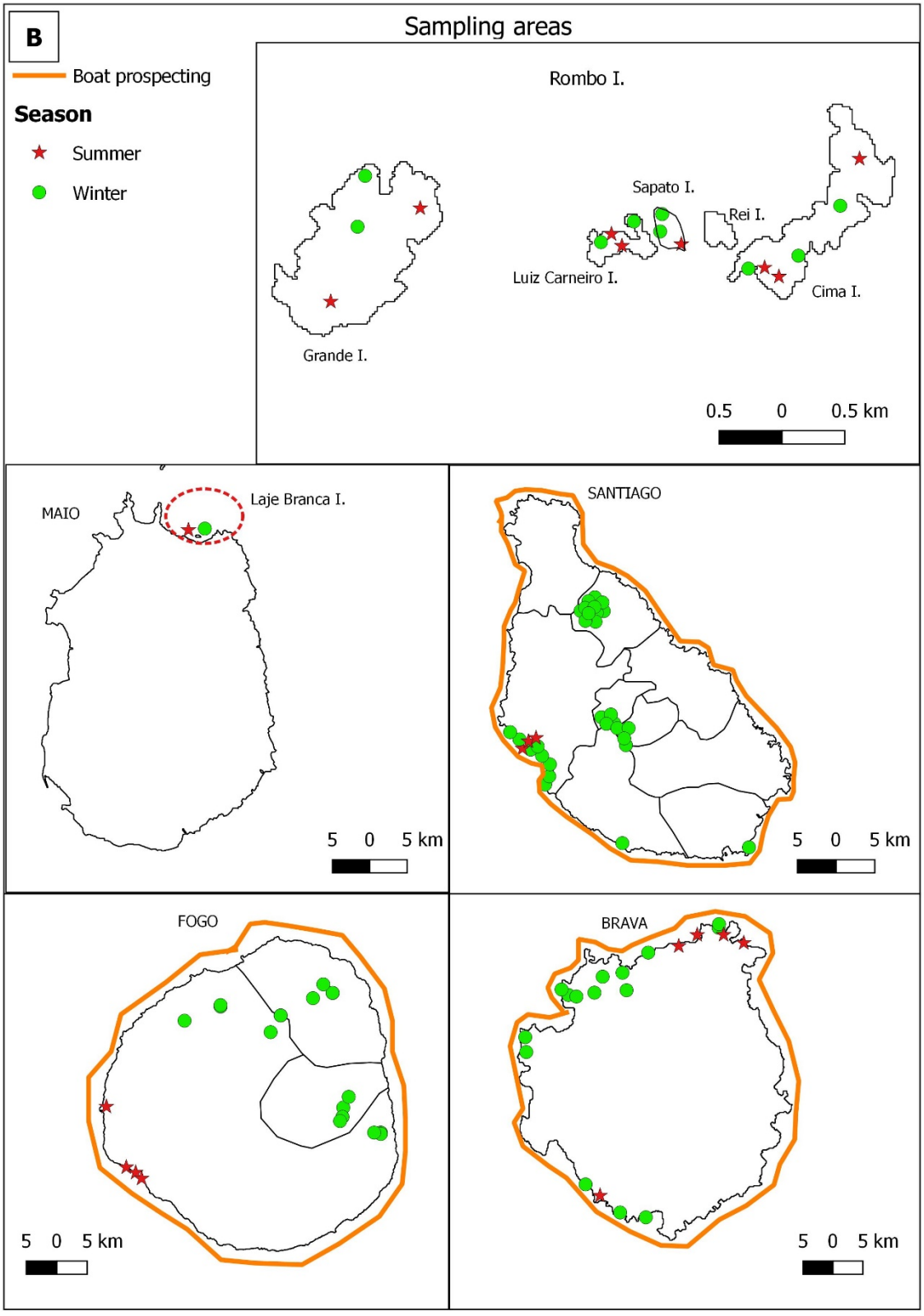
Tosco, R. B., Castro, G. D., and Anderson, M. F. (2000) La Avifauna Nidificante Del Archipielago de Cabo Verde. *Makaronesia, 2*: 43-55.

Table S2. Duration of visits by various ornithologists and collectors to the Cabo Verde archipelago (adapted from Norrevang and Hartog 1984).

Authors	Months of expeditions											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Feijó, 1783/96	■	■	■	■	■	■	■	■	■	■	■	■
Keulemans & Dorhrn, 1865	■	■	■									
Alexander, 1897	■	■	■	■								
Fea, 1897/98	■	■	■	■	■	■	■	■	■	■	■	■
Correia, 1922					■	■	■					
Blosson Expedition, 1923/24	■	■	■	■								
Bourne, 1951							■	■	■			
Naurois, 1961/65	■	■	■	■					■	■		
Bannerman & Bannerman, 1966	■	■	■									
Frade, 1969/72								■	■	■	■	■
Lambert, 1976				■						■		

Figure S1. Seabird sampling areas in the Cabo Verde (A) Barlavento and (B) Sotavento regions of the archipelago. Dashed circles indicate the surveyed islets.




B
Sampling areas
Boat prospecting
Season
Summer
Winter
Rombo I.
Grande I.
Sapato I.
Rei I.
Luiz Carneiro I.
Cima I.
0.5 0 0.5 km
MAIO
Laje Branca I.
5 0 5 km
SANTIAGO
5 0 5 km
FOGO
5 0 5 km
BRAVA
5 0 5 km