

Birds of Fernando de Noronha archipelago, Brazil

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ABSTRACT – Islands represent only 5.3% of the global land area but they are epicenters of biodiversity loss, harboring 37% of critically endangered species. Fernando de Noronha, an archipelago with 21 volcanic islets and islands 345 km off the coast of northeast Brazil, is an Important Bird Area with two endemic landbirds and nesting colonies of several seabirds. The most recent data concerning avian species in Fernando de Noronha were obtained through a meticulous review of extant literature, searches of citizen science databases, and ad libitum field surveys. In this study, 76 species of birds were recorded, with 20 residents, 22 migrants and 34 vagrants. Most of the vagrant species were found in artificial freshwater reservoirs, proving to be a critical resource. Fernando de Noronha has the highest number of breeding seabird species of any other Brazilian oceanic island, but introduced predators (rats, tegu lizards and cats) have restricted most colonies to the isolated islets. Understanding the use of the archipelago's territory and which areas are most important for these populations is key for implementing efficient conservation strategies.

Keywords: Avifauna; checklist; conservation; distribution; citizen science; oceanic island.

Aves do arquipélago de Fernando de Noronha, Brasil

RESUMO – As ilhas representam apenas 5,3% da área terrestre global e são epicentros da perda de biodiversidade, com 37% das espécies criticamente ameaçadas. O arquipélago de Fernando de Noronha, representado por 21 ilhas vulcânicas a 345 km da costa nordeste do Brasil, é uma área importante para as aves. Os dados mais recentes sobre as espécies de aves em Fernando de Noronha foram obtidos por meio de uma revisão metódica da literatura existente, pesquisas em bancos de dados de ciência cidadã e pesquisas de campo *ad libitum*. Foram registradas 76 espécies de aves, sendo 20 residentes, 22 migratórias e 34 vagantes. A maioria das espécies vagantes foi registrada em reservatórios artificiais de água doce, representando um recurso crítico. Fernando de Noronha tem o maior número de colônias reprodutivas de aves marinhas de ilhas oceânicas brasileiras, mas os predadores introduzidos (ratos, lagartos e gatos) restringiram a maioria das colônias a ilhas secundárias. Compreender o uso do território do arquipélago e quais as áreas mais importantes para essas populações é fundamental para a implementação de estratégias de conservação eficientes.

Palavras-chave: Avifauna; lista de revisão; conservação; distribuição; ecoturismo; ciência cidadã; ilhas oceânicas.

Aves del archipiélago de Fernando de Noronha, Brasil

RESUMEN – Las islas representan sólo el 5,3% de la superficie terrestre mundial y son epicentros de pérdida de biodiversidad, con un 37% de especies en peligro crítico. El archipiélago de Fernando de Noronha, formado por 21 islas volcánicas situadas a 345 kilómetros de la costa noreste de Brasil, es un Área Importante para las Aves. Los datos más recientes sobre las especies de aves en Fernando de Noronha se obtuvieron mediante una revisión metódica de la bibliografía existente, búsquedas en bases de datos de ciencia ciudadana e investigaciones de campo *ad libitum*. Se registraron un total de 76 especies de aves, 20 de las cuales son residentes, 22 migratorias y 34 errantes. La mayoría de las especies errantes se registraron en embalses artificiales de agua dulce, lo que representa un recurso crítico. Fernando de Noronha tiene el mayor número de colonias de cría de aves marinas de todas las islas oceánicas brasileñas, pero los depredadores introducidos (ratas, lagartos y gatos) han restringido la mayoría de las colonias a las islas secundarias. Comprender el uso del territorio del archipiélago y qué zonas son las más importantes para estas poblaciones es fundamental para aplicar estrategias de conservación eficaces.

Palabras llave: Avifauna; lista de revisión; conservación; distribución; ecoturismo; ciencia ciudadana; islas oceánicas.

Introduction

Oceanic archipelagos are valuable regions for understanding species diversity patterns [1] and the factors that influence species richness through ecological and historical processes [2]. The number of species and their successional stages depend on the isolation level of these areas, as well as the size, age, and complexity of prevailing environments [3][4]. Oceanic islands are known for their singular ecosystems, exhibiting high endemism, with unique species even of highly mobile organisms [5]. This makes island species very sensitive to disturbances, such as habitat loss, climate change, and predation by alien invasive species [6][7].

Although islands represent only 5.3% of the global land area [8], they are epicenters of biodiversity loss, harboring approximately one-third of critically endangered species [9][10]. Furthermore, most global extinctions occurred in island environments and birds are known to be the most affected group [10]. More than 90% of the extinct birds worldwide were insular taxa and this problem warns considering numerous island species categorized as endangered or critically endangered [9][11]. Therefore, understanding how many species are expected in a given area, as well as better recognizing their population status, is fundamental for improving conservation efforts on islands.

Brazil has five oceanic island groups: Rocas Atoll (3°63'S, 33°48'W), Fernando de Noronha (3°50'S, 32°25'W), São Pedro e São Paulo (0°46'N, 29°37'W), Trindade (20°30'S, 29°19'W), and Martim-Vaz (20°28'S, 28°51'W) Archipelagos. Together, these archipelagos have land birds, migratory birds, and around 14 breeding species of seabirds, equivalent to 14% of this last group in Brazil [12][13][14]. These islands are the only breeding sites for seabirds along an extensive zone in the South Atlantic Ocean [12][15], and many species have decreasing populations and are considered nationally endangered according to the Brazilian Red List. [16].

Fernando de Noronha is considered the most important breeding area among the Brazilian oceanic islands because it has the largest number of seabird species and is the sole nesting area for some of them [12]. It is also recognized as an Important Bird Area, being home to the iconic endemics landbirds Noronha Vireo (*Vireo gracilirostris*) and Noronha Elaenia (*Elaenia ridleyana*) [17][18]. Its main island has been long-inhabited, and today around 4,000 people live there [19]. Despite the ecological importance of the Archipelago, the information available in the literature on its avifauna is outdated and often derived solely from grey literature or citizen science platforms, with no in-depth analysis of the implications of occurrence [12][17]. This study presents an updated list of birds from the Fernando de Noronha archipelago with the inclusion of five new records. Filling this gap is important to support management and conservation policies, guide new studies, and encourage population monitoring.

Material and Method

Study area

The Fernando de Noronha Archipelago (hereafter FNA) is located in the equatorial South Atlantic (Figure 1), 345 km northeast of the Brazilian coast and belongs to the state of Pernambuco [20]. Composed of a main island with 17 km² and 20 small islands, islets and rocks, it covers a total area of 26 km² [21]. The largest island in this group is called Fernando de Noronha, with the islets of Rata, do Meio, and Sela Gineta being the largest islets extending to the northeast. A set of smaller secondary rock stacks located around its coast are used for seabird breeding as well as the two small offshore islets that hold a relict breeding population of Audubon's shearwater (*Puffinus lherminieri*) [12]. The dry season (August to January) and the rainy season (February to July) are well defined, with an average annual temperature of 27°C [21][22].

Historically, the islands' vegetation is classified as Insular Atlantic Forest [21]. However, Batistella [23] showed that the main landscape of the archipelago is predominantly xerophytic and deciduous, with characteristics similar to the vegetation of the Caatinga biome dominant in the hinterland of northeast Brazil [24]. Freitas [25] determined a significant portion of the flora is anthropogenic, the result of more than 500 years of species introductions into the archipelago, with nine endemics such as the fig tree (*Ficus noronhae*) and the cactus (*Cereus insularis*). In its territory, FNA includes two natural protected areas, managed by the federal environmental agency, the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio): the Environmental Protection Area (791.3 km²) and the National Marine Park of Fernando de Noronha (109.3 km²) (22) (Figure 1).

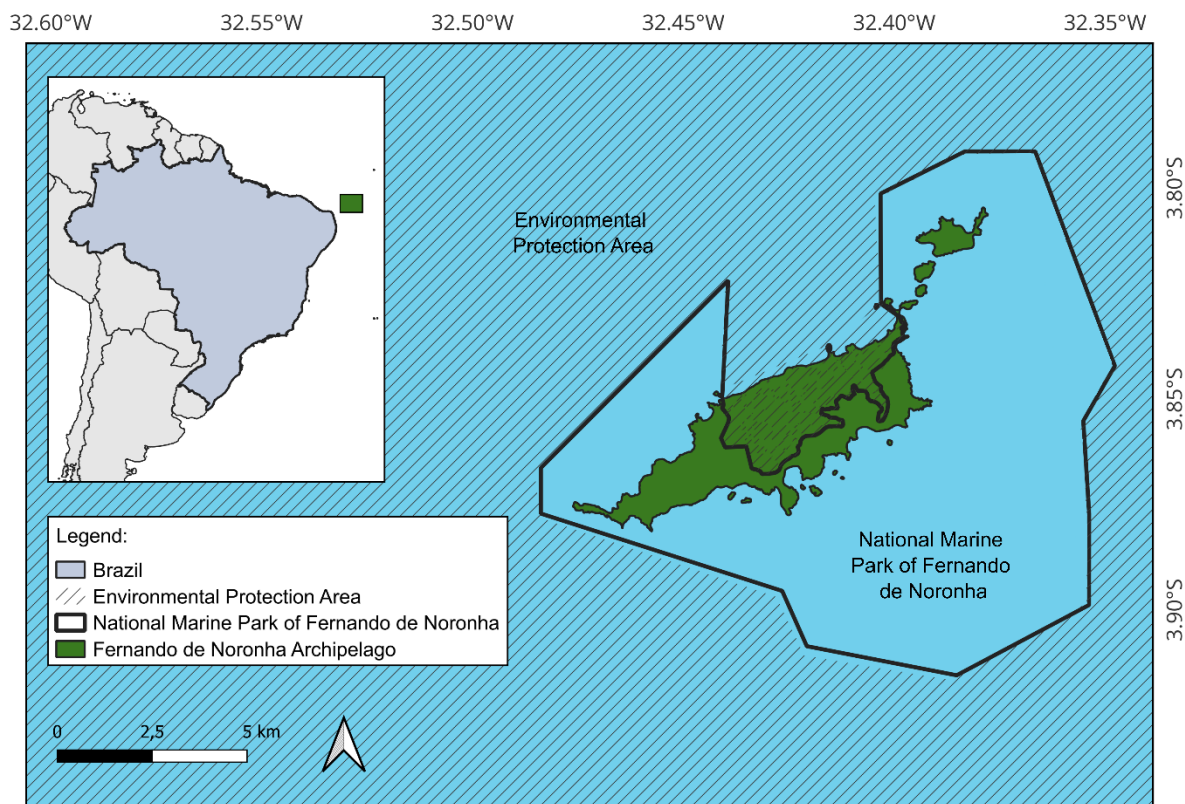


Figure 1 – Fernando de Noronha Archipelago and its protected areas: the Environmental Protection Area and the National Marine Park of Fernando de Noronha.

Data collection

This updated checklist was compiled through: 1) literature review; 2) searches in citizen science databases; and 3) on-site ad libitum surveys. In the first approach, we used Google Scholar, SpringerLink, ScienceDirect, Taylor and Francis Online, and Wiley Online Library to find peer-reviewed scientific articles, books, theses, dissertations, as well as other technical documents using terms in Portuguese and English associated with “Fernando de Noronha”, such as “birds”, “seabirds”, “avifauna”, “endemic species”, and “island birds”. Only studies published since 1845 were considered. Records exclusively published in conference posters, annals, or abstracts without a voucher specimen, photographic or sound recordings were not included. The search criteria described above were also applied to assess records in the online citizen science platforms Wikiaves (wikiaves.com.br), Xeno-canto (xenocanto.org) and eBird (ebird.org).

Moreover, ad libitum surveys were conducted periodically by the authors totalling c.500 days in c.50 expeditions between October 2010 and September 2024, covering the main island on foot and doing onboard observations around the islands. For the delimitation of the territory included in the sampling, only records at species level within the political polygons of both natural protected areas (Figure 1) were considered, including the sea limits. The taxonomy adopted follows Pacheco et al. [13]. Extinctions and non-established populations of alien invasive species were described but not listed in this update due to inaccurate data.

Status of each species in the archipelago follows the categories adapted from Somenzari et al. [13] and Pacheco et al. [14]: 1) Resident (RE): species with records of breeding activities and that occupy the same area all year round in FNA; 2) Migratory (MI): species that fly between at least one breeding site and FNA cyclically or seasonally; 3) Vagrant (VA): irregular and/or casual occurrence in FNA; 4) Endemic (END): species that

occurs and reproduces only in FNA; 5) Alien invasive species (ALI): non-native birds or those with population established in FNA related by anthropic factors. Movement directions of the migratory and vagrant birds in Brazil were described according to Pacheco et al. (14) as North American (N), South American (S), East (E), and West (W).

The habitats used by the birds were defined as marine, terrestrial, and freshwater according to IUCN [26]. The Brazilian and the international red lists and their respective conservation status and categories were used to document the threatened species [16][26].

Results

Species of Fernando de Noronha

A total of 76 species belonging to 23 families were documented in the region of the FNA between 1847 and 2025 (Table A1). Among them, 26.3% (n = 20) are residents, 28.9% (n = 22) are migratory, and 44.7% (n = 34) are vagrants (Table A1). Of the resident species, 10% (n = 2) are endemic from FNA, 15% (n = 3) are alien invasive species. The species *Bubulcus ibis*, *Paroaria dominicana* e *Passer domesticus* were considered resident according to the definition by Somenzari et al. (13). Of the migrants, 68.2% (n = 15) came from North America, 22.7% (n = 5) from South America, and 9% (n = 2) from the East, either Africa or Europe. Of the vagrants, 52.9% (n = 18) are Palearctic species also occurring in Africa, while a few came from North America (n = 9). In all birds of FNA, fifteen species (19.7%) are threatened and cited in the Brazilian and/or international red lists [16][26]; among the migrant birds, all threatened species (n = 5) come from North America. In terms of habitat use, 32.8% (n = 25) are marine, 14.4% (n = 11) are terrestrial, and 52.6% (n = 40) use freshwater (Table A1).

New findings

We present five new species to the list of birds of FNA. Our research includes the first photographic records of Ascension Frigatebird (*Fregata aquila*) in Brazil, made by Fábio Olmos in 2021, a species that was previously documented only from remote tracking [27] (Figure 3a). The species was photographed, when soaring alongside several Magnificent Frigatebirds (*F. magnificens*) and a lone juvenile stage 2 immature female Trindade Frigatebird (*F. trinitatis*), also a new register for the archipelago, made by the same photographer (Figure 3d). We also present the first records of Wilson's Phalarope (*Phalaropus tricolor*), documented by the birdwatcher Ronaldo Francisco in 2023, in Wikiaves (Figure 3b). We also present the first photographic record of Franklin's Gull (*Leucophaeus pipixcan*) in the Brazilian Northeast (Figure 3c). This species was cited in FNA [28] but was photographed only 23 years later by Carlos Marenga in 2011. Moreover, the North American migrant Scarlet Tanager (*Piranga olivacea*) was recorded by birdwatcher Bruno Galvão in 2025, on the trail to Sancho beach (Figure 3e).

Type of record

Of the records accounted for and the 76 species listed, most of the species were documented by literature review (92.1%, n = 70 species), followed by citizen science (73.7%, n = 56 species) and *ad libitum* investigations (52.6 %, n = 40 species), where each species may have been recorded by more than one type of record. A Venn diagram was created to illustrate the number of species recorded exclusively and jointly through field investigations, literature sources, and citizen science data (Figure 2). Species were assigned to one or more categories according to the type of record available. Yet some previous records were not included in this list.

Yellow-nosed Albatross (*Thalassarche chlororhynchos*) and Soft-plumaged Petrel (*Pterodroma mollis*) were documented more than 50 km from the island and remain in the gray literature. Band-rumped Storm-Petrel (*Hydrobates castro*) and Southern House Wren (*Troglodytes musculus*) were cited in congress abstracts but lack documentation. There are single records of Snowy Egret (*Egretta thula*) and Wilson's Plover (*Charadrius wilsonia*) in eBird but also without documentation. Additionally, we follow Silva e Silva [17] in excluding Cabot's Tern (*Thalasseus acuflavidus*), White-faced Whistling-Duck (*Dendrocygna viduata*), and *Stercorarius* sp. as unreliable records in the archipelago.

Lastly, seven species were introduced by humans but have no established populations in FNA and for this reason, were not included in the list: Black Vulture (*Coragyps atratus*), Sun Parakeet (*Aratinga solstitialis*), Mealy Parrot (*Amazona farinosa*), Budgerigar (*Melopsittacus undulatus*), Cockatiel (*Nymphicus hollandicus*), Saffron Finch (*Sicalis flaveola*), and White-bellied Seedeater (*Sporophila leucoptera*). In addition, remains of a flightless extinct rail were collected by Olson (30) and formal description is lacking.



Figure 2 – Venn diagram showing the number of bird species recorded through field investigations, literature review, and citizen science. Numbers indicate species unique to each data source and those shared among sources.



Figure 3 – First photographic records of birds in Fernando de Noronha Archipelago. A. Ascension Frigatebird (*Fregata aquila*) at Ilha Sela Gineta (3°49'25.7"S 32°23'36.6"W) by Fábio Olmos in 2021. B. Wilson's Phalarope (*Phalaropus tricolor*) at Xaréu (3°51'58.5"S 32°25'44.7"W) by Ronaldo Francisco in 2023. C. Franklin's Gull (*Leucophaeus pipixcan*) at the port area (3°50'03.7"S 32°24'04.0"W), by Carlos Marenga in 2011. D. Trindade Frigatebird (*F. trinitatis*) at Ilha Sela Gineta (3°49'25.7"S 32°23'36.6"W) by Fábio Olmos in 2021. E. Scarlet Tanager (*Piranga olivacea*) at the Sancho beach (3°51'14.8"S 32°25'13.1"W) by Bruno Galvão in 2025.

Discussion

Our findings emphasize that Fernando de Noronha is a crucial site for several bird species in the Atlantic Ocean, influenced by its unique oceanographic and biogeographical features. Among the Brazilian oceanic islands, FNA presents the highest richness of bird species, probably due to the diverse environments the archipelago presents, such as mangroves, freshwater and forests [12]. Close behind is Rocas Atoll with 29 species, of which seven are residents [12][15]. The islands of Trindade and Martim Vaz have 23 species, eight residents and one endemic [12][48]. Of the residents of those islands, only one species does not occur in FNA: Trindade Petrel (*P. arminjoniana*). The São Pedro and São Paulo Archipelago (hereafter, ASPSP) is the site with the lowest richness, with only three resident and reproductive species, which all of them also occur in FNA: Brown Booby (*Sula leucogaster*), Brown Noddy (*Anous stolidus*) and Black Noddy (*A. minutus*). Migratory species and sporadic visitors use the ASPSP area to rest and feed, such as Masked Booby (*S. dactylatra*), Red-footed Booby (*S. sula*), Magnificent Frigatebird (*F. magnificens*), Cattle Egret (*Bubulcus ibis*), Sooty Tern (*Onychoprion fuscatus*), and others [49], but there is no published quantification of these visitors. For those oceanic islands, new records have been published in recent years, such as Black Kite (*Milvus migrans*) [50] and Black-headed Gull (*Chroicocephalus ridibundus*) [51][52] in ASPSP and Noronha Elaenia (*E. ridleyana*) [52] in Rocas Atoll. However, there is no comprehensive list of birds from these environments, making this the first list of birds of a Brazilian oceanic island.

Species of Fernando de Noronha

Making up only 26.6% ($n = 20$) of the local birds, resident species are a minority. Their year-round presence can be attributed to the stable climatic conditions and abundant food resources provided by the rich marine and terrestrial ecosystems of Noronha [23][53][54]. Among the few resident birds are the two species that make FNA the sole Brazilian oceanic island with endemic landbirds, *V. gracilirostris* and *E. ridleyana*. For the two endemic species, there is research undertaken regarding home range, foraging and reproduction (Licarião et al. in preparation). Despite an absence of consistent methodologies, estimated population sizes ranging from 100 to 1000 individuals for Noronha Elaenia are indicated, with an average of 500 mature individuals recorded on the primary island [66][26]. For *V. gracilirostris*, the population is estimated to be between 700 and 1000 mature individuals, with a decline in population trend observed [26]. These species are survivors of a pre-colonization community that included a still-to-be-described flightless, medium-sized rail known from subfossil remains [29]. Fernando de Noronha stands out as the oceanic island in the South Atlantic with a total of 17 resident species, recorded year-round, including 11 seabirds and six landbirds. Three seabird species included in this category that stand out for being considered threatened in Brazil are the Red-billed Tropicbird (*Phaethon aethereus*), the White-tailed Tropicbird (*P. lepturus*), and the Red-footed Booby (*S. sula*) [17].

We found that most true migrants arrive in FNA from their breeding grounds in North America. Migration of Nearctic species is well-known in Brazil and climatic pathways may influence bird seasonal movements [56][57]. Seabird migration to the FNA Archipelago involves the seasonal and often long-distance movements of seabird species to this isolated region, driven by the need for favorable breeding, feeding, and resting conditions. These observations are intricately linked to the archipelago's strategic location within key oceanic currents and wind patterns, providing a crucial stopover or destination for species navigating the Atlantic, particularly those migrating from the North (68.1%, $n = 15$).

A significant 44.7% ($n = 34$) of the birds in the archipelago are vagrants, most (52.9%, $n = 18$) coming from the East (Palearctic or Africa), while fewer come from North America (26.5%, $n = 9$). Fernando de Noronha is a strategic place in South America south of the equator to find vagrants from across the Atlantic. The archipelago is positioned within the South Equatorial Current system, which flows westward across the Atlantic Ocean from Africa to South America, acting as a conveyor belt, transporting nutrients, plankton, and even birds across vast distances [58]. The high proportion of vagrants, being species migrating between the Palearctic and Africa, suggests many of these birds are either carried by the prevailing easterly winds or are following the east-to-west flow of the South Equatorial Current, although many may have been ship-assisted. This oceanic route probably facilitates the accidental arrival of species from Africa and other parts of the eastern Atlantic into FNA.

New findings

All of the new bird species registered in FNA are results of birdwatching. Breeding in the northern United States and spending the non-reproductive season on the Pacific Ocean coast (60), Franklin's Gull (*L. pipixcan*) was first sighted in Brazil in FNA in 1988 [28], with no photographic record, and then in São Paulo in 2002 [60]. Its presence in FNA was only properly recorded in 2011 and registered again in 2025 by birdwatchers, making it the easternmost record for Brazil. Occurring in the wetlands of North America and eastern Latin America, Wilson's Phalarope (*P. tricolor*) has already been recorded in southern Brazil. The record in FNA in 2023 was the first for the northeastern region of Brazil and the first in the archipelago. Ascension Frigatebird (*F. aquila*), a once widespread South Atlantic endemic, formerly breeding in Santa Helena and, very likely, FNA [29] are now on the verge of extinction [48][61]. The bird was registered in 2021 for the first time and again in July 2025, by a local birdwatcher. This species was registered at the same time as Trindade Frigatebird (*F. trinitatis*), an endemic

species that occurs only in the Trindade and Martim Vaz Archipelago [48]. Although the archipelago lies approximately 1000 km from FNA, frigatebirds are known to disperse widely across oceanic regions, suggesting that the presence of *F. trinitatis* at FNA could be observed more frequently if systematic monitoring and targeted observation efforts were encouraged. Scarlet Tanager (*P. olivacea*) was sighted and photographed by a local FNA guide on the Sancho trail in May 2025, consolidating its identification and registering the species on Wikiaves. The migratory bird occurs in North America, Central America and northern Latin America, with some records in Brazil in the Amazon region [62][63].

The presence of endemic species and the greatest diversity of seabirds in Brazil, combined with large breeding colonies, make FNA a valuable attraction for birdwatching tourism. Although citizen-science data are associated with a certain bias, they provide strong contributions to quantifying species and understanding geographical distributions when in local studies, confirmed by experts (as is the case for eBird and Wikiaves, for example) and supported by integrative methodologies [64][65]. Therefore, the combination of innovative (such as acoustic passive monitoring), traditional survey methodologies and citizen science can provide powerful information about birds' use of space and thus lead to effective actions for the conservation of these species.

Threats to bird conservation

In FNA, the bird species share the main island with alien invasive species that have thrived due to man-made habitats and the absence of natural predators [66]. Although the direct effects of invasive birds on native species have not been assessed in FNA, it is well known that invasive species can disrupt island ecosystems, potentially outcompeting or displacing resident and migratory birds and threatening their survival [67]. Among the alien species, it is likely that *B. ibis* arrived on the island naturally, while *P. dominicana* and *P. domesticus* were introduced by human action [17]. First recorded in 1980, *B. ibis* has a semi-aquatic habit and benefits from open areas, showing remarkable population growth since then and representing a risk in competition for resources and the spread of zoonoses [66]. The presence of the exotic invasive *P. domesticus* raises alarm about the expansion of populations, previously restricted to the village area, now colonizing areas of the National Park. This species may pose a risk to endemic birds due to the possibility of zoonotic transmission of infectious diseases such as avian influenza, Newcastle disease and West Nile fever, drastically affecting their populations [68].

The two endemic birds are listed in both IUCN and Brazilian list of endangered fauna, facing predation by cats, rats, and tegu lizards as the main threats, as well as changes in vegetation [53][69][70]. Among the rodent species recorded in FNA, *Rattus rattus* is the most relevant in terms of negative impacts [66][71]. There are still no published studies on the population size and distribution of the invasive species throughout the Archipelago [71]. However, data from experiments carried out indicate high predation rates on eggs of endemic birds by rats (Licarião in prep.).

On an island with a scarcity of freshwater sources, it is interesting that most of the species recorded are associated with freshwater habitats (53.3%, $n = 40$). Of these, 10% ($n = 4$) are threatened and all are migrants from the northern hemisphere. These birds, often under pressure from habitat loss or climate change in their northern breeding grounds [72], find refuge in the relatively stable and resource-rich environments of FNA. In the archipelago, these birds are associated with reservoirs, reinforcing the importance of this man-made resource for this group. Freshwater on the island is scarce and demand is divided between the community and local fauna.

Of all the seabird species in FNA, 36% ($n = 9$) are threatened either nationally or globally. Nesting species are more susceptible to local threats like predation by alien invasive species such as cats, rats, and lizards [53][73] and habitat loss. That is the case of the Red-footed Booby (*S. sula*), which are undergoing a serious threat in available nesting areas with dependent-large plants, such as the endemic fig trees, which could be lost at

increasing rates, with added competition for nesting sites with the introduced Cattle Egret [12][73]. Audubon's Shearwater (*P. lherminieri*) in Brazil has its only breeding sites on two small islands in the archipelago, Ilha da Viúva and Ilha do Leão. Individuals are reported breeding on the islands annually, but in the last four years the numbers have been less than three per breeding season, a different reality from 2004 when 20 pairs were recorded in the nesting area [17][74]. Its sedentary habits and small population make this seabird very vulnerable to human disturbance and predation by introduced mammals, which can easily lead to local extinction [17][75].

Regardless of their habitat, all birds in FNA are under pressure from the same major threat: predation by rats and cats. Feral cats are thought to have been a major driver of biodiversity loss causing extinctions of insular endemic birds and local extinctions of island breeding seabirds [76][77][78] and is a worldwide problem [79][80]. In 2017, it was estimated that the population density of cats in FNA was 2 individuals per hectare, totaling around 1287 cats on the main island [71][81]. At the time, there was also an indication of a 41% annual population increase [66]. In addition, studies carried out in FNA reveal that 28.6% of the diet of domestic cats on the island is made up of wild birds and 18% is referent to the endemic lizard (*Trachylepis atlantica*) [53]. This data highlights the urgency of controlling the exotic cat population in FNA, as it is one of the main threats to local avifauna. Population control strategies through capture and neutering have been implemented occasionally in the archipelago but have not achieved the expected success in mitigating this problem in an island environment [71].

In this scenario, rats (Norway, Black and Mice) are also widespread in FNA, including in some of the secondary islands like Ilha Rata. These predators have already excluded ground-nesting seabirds like the Sooty Tern (*O. fuscatus*), Brown Booby (*S. leucogaster*), Masked Booby (*S. dactylatra*), Red-footed Bobbie (*S. sula*) and Audubon Shearwater (*P. lherminieri*) from islets where cats are present and rats are either present or rare and exert heavy pressure on the main island, accounting for high levels of nest failure [66][71]. In addition, the presence of rats is a major obstacle to the survival of endemic species, due to nest predation. At this moment, there are no available estimates of the population size and distribution of *R. rattus* throughout the entire archipelago [71].

Some rat eradication programs have been highly successful on islands all over the world [82], including an action carried out at Meio Island in FNA by poison baits [66]. Meio island, which is less than 17 hectares and was never inhabited, had a preliminary study in 2016 indicating a very high density of 322 to 590 rats per hectare [66]. A rat population, estimated about 5,000 to 9,300 were removed from the wild and the next step is to extend the project to a larger island, Ilha Rata (personal communication Ricardo Araújo ICMBio). On the other hand, initiatives involving cats have faced higher logistic problems, due to the social demands for the use of non-invasive methods, and efficient methods to address feral cat populations.

Conclusions

Our outcomes reveal Fernando de Noronha Archipelago as the richest oceanic island in Brazil in terms of seabird diversity. However, it is necessary to point out urgent actions to mitigate the main local threats associated with this group. The presence of invasive species mainly cats and rats poses the most significant threat to both seabirds and landbirds through nest predation. The eradication of rats from one secondary island has shown success, but it is crucial to extend these efforts to the main island. Control of feral cats should also be prioritized, using non-invasive methods that balance ecological needs with social concerns. Similar efforts should be applied to control Tegu lizards, which also contribute to predation pressures.

In terms of restoration of native vegetation, it is necessary to counteract the spread of invasive plant species such as the lead tree (*Leucaena leucocephala*) and common lantana (*Lantana camara*). This action would help recover lost nesting sites, particularly for seabirds like the Red-footed Booby that rely on large trees. In parallel,

it is important to establish regular monitoring programs regarding bird population in FNA [12][34] integrated with the assessment of native vegetation and ecological restoration.

Regarding endemic birds, comprehensive studies on the population size, distribution, and trends of Noronha Elaenia and Noronha Vireo is necessary to better understand their conservation status and needs. For this, it is important to keep the citizen science in bird monitoring efforts, ensuring that data collected is reliable and integrated into broader conservation strategies.

The increase in tourism and changes in the land use and infrastructure of Fernando de Noronha will eventually increase the impact on its bird composition. It is urgent to improve public awareness among tourists and the local population about the human impact on local bird species and implement guidelines and restrictions as needed to minimize it. These actions require coordinated efforts among environmental agencies, researchers, and the local community to ensure the long-term conservation of Fernando de Noronha's unique avifauna.

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Appendix

Table A1 – Bird species recorded in the Fernando de Noronha Archipelago between 1847 and 2025. Status: MI = migratory; MI (E) = migratory from East; MI (N, E) = migratory from North and East; MI (N) = migratory from North; MI (S) = migratory from South; RE = resident; RE EN = endemic resident; RE ALI = alien invasive resident; VA = vagrant; VA (N) = North vagrant; VA (E) = East vagrant; VA (S) = South vagrant; VA (W) = West vagrant. Global Conservation Status following IUCN (27): LC = least concern; NT = near threatened; VU = vulnerable. National Conservation Status following Brazilian Ministry of the Environment [16]: CR = critically endangered; EN = endangered; VU = vulnerable. Type of record: Li = literature; Inv = investigation; Cs = citizen science; Occurrence status = occur. status; Conservation status = cons. status.

Taxon	Occurr. status	Cons. status IUCN	Cons. status MMA	Habitat	Records						Type Of record
					1847-1922	1960-1979	1980-1989	1990-1999	2000-2010	2011-2023	
Anatidae											
Anas acuta (Linnaeus, 1758)	VA (N)	LC	NA	Freshwater			x		x	x	Li [28][30] Cs
Diomedidae											
Thalassarche melanophris* (Temminck, 1828)	MI (S)	LC	NT	Marine							Li [31]
Procellariidae											
Calonectris borealis* (Cory, 1881)	MI (E)	LC	LC	Marine							Li [31]
Ardenna grisea (Gmelin, 1789)	MI (S)	NT	NA	Marine						x	Li [32][34]

<i>Ardenna gravis</i> (O'Reilly, 1818)	MI (S)	LC	NA	Marine					x		Li [17]
<i>Puffinus puffinus</i> (Brünnich, 1764)	MI (N)	LC	LC	Marine			x				Li (34)
<i>Puffinus lherminieri</i> (Lesson, 1839)	RE	LC	CR	Marine					x	x	Inv, Cs, Li [34]
Oceanitidae											
<i>Fregatta tropica</i> (Gould, 1844)	MI (S)	LC	LC	Marine		x				x	Inv, Li [34][35]
<i>Oceanites oceanicus</i> (Kuhl, 1820)	MI (S)	LC	LC	Marine		x					Li [36]
Hydrobatidae											
<i>Hydrobates leucorhous</i> (Vieillot, 1818)	VA (N)	VU	NA	Marine		x			x	x	Li [34][36][45]
Phaethontidae											
<i>Phaethon aethereus</i> (Linnaeus, 1758)	RE	LC	EN	Marine		x		x	x	x	Inv, Li [31], Cs
<i>Phaethon lepturus</i> (Daudin, 1802)	RE	LC	EN	Marine		x		x	x	x	Inv, Li [31], Cs
Fregatidae											
<i>Fregata magnificens</i> (Mathews, 1914)	RE	LC	LC	Marine		x		x	x	x	Inv, Li [31], Cs
<i>Fregata minor</i> (Gmelin, 1789)	VA (S)	LC	CR	Marine					x		Li [37]
<i>Fregata aquila</i> (Linnaeus, 1758)	VA (E)	VU	NA	Marine			x			x	Inv, Li [28]
<i>Fregata trinitatis</i> (Miranda-Ribeiro, 1919)	VA (S)	NA	CR	Marine						x	Inv
Sulidae											
<i>Sula dactylatra</i> (Lesson, 1831)	RE	LC	LC	Marine		x		x	x	x	Inv, Li [31], Cs
<i>Sula sula</i> (Linnaeus, 1766)	RE	LC	EN	Marine		x		x	x	x	Inv, Li [31], Cs
<i>Sula leucogaster</i> (Boddaert, 1783)	RE	LC	LC	Marine		x		x	x	x	Inv, Li [31], Cs
Ardeidae											
<i>Nycticorax nycticorax</i> (Linnaeus, 1758)	RE SI	LC	LC	Freshwater			x		x	x	Inv, Li [28] [17], Cs
<i>Butorides striata</i> (Linnaeus, 1758)	VA	LC	LC	Freshwater			x		x	x	Li [31], Cs
<i>Ardeola ralloides</i> (Scopoli, 1769)	RE SI	LC	NA	Freshwater			x		x	x	Inv, Li [31], Cs
<i>Bubulcus ibis</i> (Linnaeus, 1758)	RE ALI	LC	LC	Freshwater			x		x	x	Inv, Li [31] [28], Cs

<i>Ardea cinerea</i> (Linnaeus, 1758)	VA (E)	LC	NA	Freshwater					x	x	Inv, Li [39], Cs
<i>Ardea cocoi</i> (Linnaeus, 1766)	VA (W)	LC	LC	Freshwater			x			x	Li [31], Cs
<i>Ardea purpurea</i> (Linnaeus, 1766)	VA (E)	LC	NA	Freshwater			x			x	Inv, Li [31], Cs
<i>Ardea alba</i> (Linnaeus, 1758)	VA	LC	LC	Freshwater	x					x	Li [31], Cs
<i>Egretta tricolor</i> (Statius Muller, 1776)	VA (E)	LC	LC	Freshwater			x				Li (38)
<i>Egretta gularis</i> (Bosc, 1792)	VA (E)	LC	NA	Freshwater				x	x		Li [32][38][30], Cs
<i>Egretta garzetta</i> (Linnaeus, 1766)	VA (E)	LC	NA	Freshwater						x	Inv, Li [41], Cs
<i>Egretta caerulea</i> (Linnaeus, 1758)	VA	LC	LC	Freshwater						x	Inv, Cs
Threskiornithidae											
<i>Platalea leucorodia</i> (Linnaeus, 1758)	VA (E)	LC	NA	Freshwater				x			Li [31][38][41]
Rallidae											
<i>Crex crex</i> (Linnaeus, 1758)	VA (E)	LC	NA	Freshwater						x	Li [40], Cs
<i>Porphyrio martinica</i> (Linnaeus, 1766)	RE SI	LC	LC	Freshwater			x		x	x	Inv, Li [31][17], Cs
<i>Porphyrio alleni</i> (Thomson, 1842)	VA (E)	LC	NA	Freshwater						x	Li [39], Cs
Charadriidae											
<i>Pluvialis dominica</i> (Statius Muller, 1776)	VA (N)	LC	DD	Freshwater	x	x	x	x	x	x	Inv, Li [36], Cs
<i>Pluvialis squatarola</i> (Linnaeus, 1758)	VA (N)	LC	LC	Freshwater			x	x	x	x	Inv, Li [38], Cs
<i>Charadrius semipalmatus</i> (Bonaparte, 1825)	VA (N)	LC	LC	Freshwater			x	x	x	x	Inv, Li [38], Cs
Scolopacidae											
<i>Limosa lapponica</i> (Linnaeus, 1758)	VA (E)	NT	NA	Freshwater			x	x	x	x	Li [30][43][44][45], Cs
<i>Limnodromus griseus</i> (Gmelin, 1789)	MI (N)	LC	EN	Freshwater			x				Inv, Li [38], Cs
<i>Phalaropus tricolor</i> (Vieillot, 1819)	VA (N)	LC	DD	Freshwater						x	Cs
<i>Numenius hudsonicus</i> (Latham, 1790)	MI (N)	LC	VU	Freshwater					x	x	Inv, Li [31][17][44], Cs
<i>Numenius phaeopus</i> (Linnaeus, 1758)	VA (E)	LC	NA	Freshwater		x	x	x	x	x	Inv, Li [46], Cs

<i>Actitis macularius</i> (Linnaeus, 1766)	MI (N)	LC	LC	Freshwater			x			x	Inv, Li [38], Cs
<i>Tringa melanoleuca</i> (Gmelin, 1789)	MI (N)	LC	LC	Freshwater				x	x		Li [38][44]
<i>Tringa flavipes</i> (Gmelin, 1789)	MI (N)	LC	LC	Freshwater			x	x	x	x	Inv, Li [31] [17][44], Cs
<i>Tringa semipalmata</i> (Gmelin, 1789)	VA (N)	LC	LC	Freshwater			x	x			Inv, Li [44], Cs
<i>Tringa totanus</i> (Linnaeus, 1758)	VA (E)	LC	NA	Freshwater				x			Li [32]
<i>Tringa glareola</i> (Linnaeus, 1758)	VA (E)	LC	NA	Freshwater						x	Li [39]
<i>Arenaria interpres</i> (Linnaeus, 1758)	MI (N)	LC	NT	Freshwater	x	x	x	x	x	x	Inv, Li [36] [17], Cs
<i>Calidris canutus</i> (Linnaeus, 1758)	MI (N)	NT	VU	Freshwater			x		x	x	Li [28], Cs
<i>Calidris alba</i> (Pallas, 1764)	MI (N)	LC	LC	Freshwater			x	x	x	x	Inv, Li [31] [17][44], Cs
<i>Calidris pusilla</i> (Linnaeus, 1766)	MI (N)	NT	EN	Freshwater					x	x	Cs
<i>Calidris minutilla</i> (Vieillot, 1819)	MI (N)	LC	DD	Freshwater			x				Li [31][38]
<i>Calidris minuta</i> (Leisler, 1812)	VA (E)	LC	NA	Freshwater						x	Li [47], Cs
<i>Calidris fuscicollis</i> (Vieillot, 1819)	MI (N)	LC	LC	Freshwater			x		x	x	Li [28][17], Cs
<i>Calidris melanotos</i> (Vieillot, 1819)	MI (N)	LC	LC	Freshwater			x			x	Li [28], Cs
Laridae											
<i>Leucophaeus pipixcan</i> (Wagler, 1831)	VA (N)	LC	LC	Freshwater			x			x	Li [28], Cs
<i>Larus dominicanus</i> (Lichtenstein, 1823)	VA	LC	LC	Marine					x		Li [30], Cs
<i>Anous stolidus</i> (Linnaeus, 1758)	RE	LC	LC	Marine	x	x	x	x	x	x	Inv, Li [31], Cs
<i>Anous minutus</i> (Boie, 1844)	RE	LC	LC	Marine	x	x	x	x	x	x	Inv, Li [31], Cs
<i>Gygis alba</i> (Sparman, 1786)	RE	LC	NT	Marine	x	x	x	x	x	x	Inv, Li [31], Cs
<i>Onychoprion fuscatus</i> (Linnaeus, 1766)	RE	LC	LC	Marine	x	x	x	x	x	x	Inv, Li [31], Cs
<i>Sterna hirundo</i> (Linnaeus, 1758)	MI (N, E)	LC	LC	Marine					x	x	Inv, Li [17], Cs
<i>Thalasseus maximus</i> (Boddaert, 1783)	MI (N)	LC	EN	Marine			x				Li [31]

Columbidae											
<i>Columba livia</i> (Gmelin, 1789)	VA (E)	LC	NA	Terrestrial				x		x	Inv, Li [42] [44], Cs
<i>Zenaida auriculata</i> (Des Murs, 1847)	RE	LC	LC	Terrestrial	x	x	x	x	x	x	Inv, Li [31], Cs
Falconidae											
<i>Falco peregrinus</i> (Tunstall, 1771)	MI	LC	LC	Terrestrial			x	x			Li [28]
Cuculidae											
<i>Cuculus canorus</i> (Linnaeus, 1758)	VA (E)	LC	NA	Terrestrial						x	Li [39], Cs
Tyrannidae											
<i>Elaenia ridleyana</i> (Sharpe, 1888)	RE EN	VU	VU	Terrestrial	x	x	x	x	x	x	Inv, Li [28] [31], Cs
Vireonidae											
<i>Vireo gracilirostris</i> (Sharpe, 1890)	RE EN	NT	VU	Terrestrial	x	x	x	x	x	x	Inv, Li [27] [30], Cs
Hirundinidae											
<i>Progne chalybea</i> (Gmelin, 1789)	VA (E)	LC	LC	Terrestrial			x				Li [31]
<i>Hirundo rustica</i> (Linnaeus, 1758)	VA (E)	LC	LC	Terrestrial			x			x	Li [38], Cs
Thraupidae											
<i>Paroaria dominicana</i> (Linnaeus, 1758)	RE ALI	LC	LC	Terrestrial					x	x	Inv, Li [31][33] [17][38], Cs
Passeridae											
<i>Passer domesticus</i> (Linnaeus, 1758)	RE ALI	LC	NA	Terrestrial				x	x	x	Inv, Li [41], Cs
Cardinalidae											
<i>Piranga olivacea</i> (Gmelin, 1789)	VA (N)	LC	LC	Terrestrial						x	Cs

* Species in the Museum of Natural Sciences of Recife (Pernambuco, Brazil) has an unsexed specimen obtained "off Fernando de Noronha" on an unspecified collection date.

In order to locate the required literature records, the numbers entered within the table of references must be consulted.

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