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## Apparent range expansion or recolonization of Puerto Rican Nightjars (Guabairo; *Antrostomus noctitherus*) on the Cabo Rojo National Wildlife Refuge

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Photo: Mike J. Morel

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Cover Page: Puerto Rican Nightjar (*Antrostomus noctitherus*) in Guánica Dry Forest, Puerto Rico on 24 April 2012. Photographed by Mike J. Morel (mikemorelphotography.zenfolio.com).

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### Abstract

The Puerto Rican Nightjar (Guabairo, *Antrostomus noctitherus*) is an Endangered bird species endemic to Puerto Rico. Typically inhabiting subtropical dry and lower montane forests, the species is currently rare to locally common from the southwest coast eastward to Guayama. However, based on the most recent population modeling from 2010 and individual observations made by community members, nightjars may be more abundant and widely distributed than previously known. Consistent with this, during November and December 2021, we observed at least two Puerto Rican Nightjars on the Cabo Rojo National Wildlife Refuge in southwestern Puerto Rico, where the species has not been previously reported. Given the presence of this species in nearby areas of the Cabo Rojo municipality (e.g., in Punta Melones), our observations suggest a range expansion or recolonization, and could reflect an increase in species abundance. Targeted population monitoring and spatial tracking of the Puerto Rican Nightjar are needed to enable more robust population estimates that will inform future evaluations of this endangered endemic's conservation status. We further recommend additional land protection measures to safeguard suitable nightjar breeding habitat in the Cabo Rojo region.

### Keywords

*Antrostomus noctitherus*, Caprimulgidae, Endangered species, Puerto Rican Nightjar, Puerto Rico, range expansion

### Resumen

**Expansión aparente del área de distribución o recolonización del Guabairo puertorriqueño (*Antrostomus noctitherus*) en el Refugio Nacional de Vida Silvestre de Cabo Rojo** • El Guabairo puertorriqueño (*Antrostomus noctitherus*) es una especie de ave endémica de Puerto Rico en peligro de extinción. Generalmente habita en bosques subtropicales secos y montanos bajos y en la actualidad se considera una especie rara o localmente común desde la costa suroeste hacia el este hasta Guayama. Sin embargo, según el modelo de población más reciente de 2010 y las observaciones individuales realizadas por miembros de la comunidad, los guabairos podrían ser más abundantes y estar más ampliamente distribuidos de lo que se conocía anteriormente. En consonancia con esto, durante noviembre y diciembre de 2021, observamos al menos dos guabairos puertorriqueños en el Refugio Nacional de Vida Silvestre de Cabo Rojo en el suroeste de Puerto Rico, donde la especie no había sido reportada previamente. Dada la presencia de esta especie en áreas cercanas del municipio Cabo Rojo (por ejemplo, en Punta Melones), nuestras observaciones sugieren una expansión del área de distribución o recolonización, y podrían reflejar un aumento en su abundancia. Se necesitan monitoreos poblacionales dirigidos y seguimientos espaciales del Guabairo puertorriqueño para tener estimaciones poblacionales más robustas que sirvan de base para evaluaciones futuras del estado de conservación de esta especie endémica en peligro de extinción. Además, recomendamos medidas adicionales de protección del territorio para salvaguardar el hábitat adecuado para la reproducción de *A. noctitherus* en la región de Cabo Rojo.

### Palabras clave

*Antrostomus noctitherus*, Caprimulgidae, especie en peligro de extinción, expansión del área de distribución, Guabairo puertorriqueño, Puerto Rico

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## Résumé

**Expansion de l'aire de répartition ou recolonisation apparente de l'Engoulevent de Porto Rico (Guabairo ; *Antrostomus noctitherus*) dans le Cabo Rojo National Wildlife Refuge** • L'Engoulevent de Porto Rico (Guabairo, *Antrostomus noctitherus*) est une espèce d'oiseau en danger, endémique de Porto Rico. Occupant généralement les forêts subtropicales sèches et les forêts de montagne de basse altitude, l'espèce est actuellement considérée comme rare à localement commune depuis la côte sud-ouest jusqu'à Guayama vers l'est. Cependant, d'après la modélisation la plus récente de la population en 2010 et les observations ponctuelles faites par des membres de la communauté, les engoulevents pourraient être plus abondants et plus largement présents que ce qui était connu auparavant. En novembre et décembre 2021, nous avons observé au moins deux Engoulevents de Porto Rico dans le Cabo Rojo National Wildlife Refuge, dans le sud-ouest de Porto Rico, où l'espèce n'avait jamais été signalée. Compte tenu de la présence de cette espèce dans des zones voisines de la municipalité de Cabo Rojo (p. ex. à Punta Melones), nos observations suggèrent une expansion de l'aire de répartition ou une recolonisation, et pourraient refléter une augmentation de l'abondance. Un suivi ciblé de la population et un suivi spatial de l'Engoulevent de Porto Rico sont nécessaires pour permettre des estimations plus fiables de la population qui contribueront aux évaluations futures du statut de conservation de cette espèce endémique en danger. Nous recommandons en outre des mesures supplémentaires de protection des terres pour protéger l'habitat de nidification de cet engoulevent dans la région de Cabo Rojo.

## Mots clés

*Antrostomus noctitherus*, Caprimulgidae, Engoulevent de Porto Rico, espèce en danger, expansion de l'aire de répartition, Porto Rico

The Puerto Rican Nightjar (*Antrostomus noctitherus*), locally known as Guabairo, is a federally Endangered species endemic to Puerto Rico (BirdLife International 2016, USFWS 2023). The earliest records of this species (1880–1911) are from the moist forests of northern karst regions in Puerto Rico (Wetmore 1916, 1919, 1922). Puerto Rican Nightjars then went unrecorded for 50 years and were presumed extinct due to the introduction of the small Indian mongoose (*Herpestes auro-punctatus*) around 1877 (Danforth 1936, Vilella and Zwank 1993). The nightjar was “rediscovered” in 1961 in the Guánica Commonwealth Forest, 62 km southwest of the last recorded sighting in 1911 (Reynard 1962).

Currently, nightjars are found primarily in dry semideciduous forests with dense leaf litter and open understory, and they are mostly restricted to southern Puerto Rico from Cabo Rojo to Guayama (Castro-Prieto et al. 2021, Raffaele et al. 2021). Nightjars are rare to locally common in and around the Guánica Commonwealth Forest (Kepler and Kepler 1972, Vilella and Zwank 1993, Castro-Prieto et al. 2021), where they are typically found in semideciduous and evergreen forests above 75 m elevation (Vilella 2020, Castro-Prieto et al. 2021, Raffaele et al. 2021). They occur in lower numbers in Guánica's xeric coastal scrub (Vilella 1995). After Guánica Commonwealth Forest, the largest continuous nightjar habitat is the dry limestone forests of the Guayanilla-Peñuelas hills, particularly along slopes and ridges (González 2010). Nightjars also occur in the higher elevation forests of Maricao and Susúa Commonwealth Forests, but in Susúa, they are more abundant in the southern part of the forest, where they are restricted to drier areas on steep slopes and ridges (Vilella 2020). Puerto Rican Nightjars also occur in parts of La Parguera and Sierra Bermeja in Lajas and Guaniquilla, El Combate, and Peñones de Melones in Cabo Rojo (Castro-Prieto et al. 2021). Importantly, an estimated 47–81.4% of nightjar habitat is located on privately owned lands (Vilella and Zwank 1993, González 2010), and only ~14% of lands on which nightjar breeding has been documented are formally protected (Castro-Prieto et al. 2021).

Puerto Rican Nightjars are nocturnal and cryptic, making them difficult to observe and study. As aerial insectivores, night-

jars feed on flying insects during crepuscular hours and at night (Vilella 2020), apparently preferring to forage in open areas along forest trails and roads (MJM pers. obs.). Males maintain territories year-round, singing throughout the year (Vilella 2020). Singing increases during the latter half of December when territorial interactions among males become more frequent (Vilella 1995). Nests are situated on the ground, putting them at risk of predation by the small Indian mongoose, feral cats and dogs, and some bird species (e.g., Pearly-eyed Thrasher, *Margarops fuscatus*; Raffaele et al. 1998, Vilella 2020). Carnivorous ants can overwhelm and kill chicks, and Short-eared Owls (*Asio flammeus*) have been observed hunting immature birds (Vilella 1989).

Despite significant predation pressures, Puerto Rican Nightjars are predominantly threatened by anthropogenic habitat loss and degradation, particularly on privately owned lands. It is thus critical to establish a connected network of protected habitat across wildlife refuges/reserves and private lands to ensure the species' recovery and persistence (González 2010, Vilella 2020). The most recent population density estimates of Puerto Rican Nightjars (1.63 nightjars/ha in Guánica Commonwealth Forest and 0.86 nightjars/ha in Susúa Commonwealth Forest; González 2010) suggest that nightjars may be more abundant and widely distributed than previously believed, with predicted habitat including sites along the southern and southeastern coasts of Puerto Rico (González 2010, Vilella 2020, Castro-Prieto et al. 2021, Raffaele et al. 2021, USFWS 2023). Here, we report Puerto Rican Nightjars on the Cabo Rojo National Wildlife Refuge (hereafter, Cabo Rojo NWR) in southwestern Puerto Rico—a protected site where, to the best of our knowledge, the species has not previously been documented.

## Observations

Observations were made opportunistically during ongoing field research on Smooth-billed Anis (*Crotophaga ani*) that took place between October and December 2021 on Cabo Rojo NWR and adjacent property (details below). All observers had permission to be on the refuge (USFWS Permit No. 41527-2022-01).

We heard one or two Puerto Rican Nightjars singing on ten occasions between 19 November and 18 December 2021 at four



locations on Cabo Rojo NWR (17°58'30"N, 67°10'05"W) and at one location on adjacent private property owned by Finca Altamira (Table 1). We obtained audio recordings of a nightjar singing on three occasions and visually observed a nightjar on two occasions. All observations and audio files were submitted to eBird as a Trip Report (Grievés 2021).

At 0530 and 0600 on 19 and 21 November, respectively, we heard two Puerto Rican Nightjars singing simultaneously in a central location (Fig. 1, point 1) in Cabo Rojo NWR. On 19 November, we used a Google Pixel 3 phone to make an audio recording of one bird singing. At 2040 on 19 November, we returned to the location to attempt to better document our initial observation and heard a single individual singing. We used minimal playback of nightjar song ( $\leq 1$  min total, in 10-s increments at 50-m intervals while walking along a trail) to attract the bird so visual confirmation of the species could be made. All observers briefly viewed the bird with a Bushnell Equinox nightscope (model 260140), and an audio recording was made using an Olympus Digital Voice recorder (model VN-702 PC) and Boya microphone (model BY-MMA).

We heard a single bird singing in a separate location (Fig. 1, point 2) at 1827 on 27 November and at 0620 on 18 December. At 0607 on 26 November, 0600 on 27 November, and 1822 on 3 December, we heard a single bird singing at a third location (Fig. 1, point 3). At 1841 on 1 December, we heard a single bird singing at a fourth location (Fig. 1, point 4), when a third audio recording was made. At 0620 on 17 December, we heard a nightjar singing at a fifth location (Fig. 1, point 5), and LAG observed the individual flying back and forth across the trail, presumably foraging. The bird perched at about head height on a tree branch at the trail edge and was directly observed with Nikon Monarch binoculars for ~3–5 min.

Given the relatively short distance between all five sites, the same bird was likely heard on multiple occasions at multiple sites. However, two birds were heard singing before dawn on

19 and 21 November, so we conclude there were at least two Puerto Rican Nightjars on the refuge and surrounding property. Due to the low light conditions and the relatively few times we observed birds visually, no photographs were obtained; however, our audio recordings leave no doubt as to species identification. As far as we can determine, these observations represent the first confirmed reports of Puerto Rican Nightjars in the Cabo Rojo NWR (eBird 2023; Castro-Prieto *et al.* 2021).

Puerto Rican Nightjars were observed close to walking trails on the Cabo Rojo NWR in areas primarily consisting of subtropical dry forest in secondary succession (except Fig. 1, point 3, which is a narrow band of riparian vegetation running along an ephemeral watercourse surrounded by pasture). At all locations, the elevation was ~20–26 m (except Fig. 1, point 2, where the elevation is ~11 m), canopy height was ~4–6 m, and the forest floor was a mix of dense grasses (~0.3 m high), shallow leaf litter, and bare ground.

## Discussion

The Cabo Rojo NWR was established in 1974 and is one of nine refuges managed by the Caribbean Islands National Wildlife Refuge Complex (USFWS n.d.). Habitat on the Cabo Rojo NWR is primarily mixed open field and subtropical dry forest in secondary succession (Robertson *et al.* 2018, Quinn and Startek-Foote 2020). Given its proximity to known locations for Puerto Rican Nightjars (e.g., Guaniquilla, El Combate, and Peñones de Melones in Cabo Rojo and La Parguera and Sierra Bermeja in Lajas; Vilella and Zwank 1993, Castro-Prieto *et al.* 2021) and the generally suitable foraging habitat in Cabo Rojo NWR, we believe continued monitoring of the Cabo Rojo NWR and surrounding area for Puerto Rican Nightjars is warranted. Accordingly, we have submitted our sightings to the Cabo Rojo NWR management staff and to the U.S. Fish and Wildlife Service staff in charge of the most recent Puerto Rican Nightjar 5-year status review (USFWS 2023).

**Table 1.** Observations of Puerto Rican Nightjars made on Cabo Rojo National Wildlife Refuge and surrounding private property (Finca Altamira) between 19 November and 18 December 2021. Points refer to those described in the main text and as indicated in Fig. 1B. Lat-long coordinates are approximate, to keep the exact locations of this Endangered species confidential.

Date	Time	Location	Coordinates	Number of Birds	Observation Type	Number of Observers	Media Obtained
19 November	0530–0600	1	17°58'30.0"N 67°09'50.4"W	2	heard	4	audio
19 November	2040–2100	1	17°58'30.0"N 67°09'50.4"W	1	heard, saw	5	audio
21 November	0600	1	17°58'30.0"N 67°09'50.4"W	2	heard	1	–
26 November	0607	3	17°58'55.2"N 67°09'46.8"W	1	heard	1	–
27 November	~0600	3	17°58'55.2"N 67°09'46.8"W	1	heard	1	–
27 November	1827	2	17°58'40.8"N 67°10'01.2"W	1	heard	1	–
1 December	1841–2027	4	17°58'26.4"N 67°09'39.6"W	1	heard	2	audio
3 December	1822	3	17°58'55.2"N 67°09'46.8"W	1	heard	1	–
17 December	0620	5	17°58'48.0"N 67°09'46.8"W	1	heard, saw	1	–
18 December	0620	2	17°58'40.2"N 67°10'01.2"W	1	heard	1	–

Puerto Rican Nightjars typically breed from February to July, so it will be of particular importance to monitor Cabo Rojo NWR for evidence of breeding activity during these months. However, nightjars typically nest on leaf litter, within 1 m of the base of a small tree, and nests are typically situated in areas with relatively greater leaf litter biomass and canopy closure and lower mid-story stem density (Vilella 2008); thus, Cabo Rojo NWR may lack suitable nesting habitat (MJM pers. obs.), particularly considering that the locations in which we observed nightjars had either dense tall grass, bare ground, or only sparse leaf litter. Nightjars are territorial, and breeding pairs exhibit strong nest-site fidelity (Vilella 2020). Based on radio tracking data from two males monitored for approximately 24 h, home ranges were estimated as 4.8 and 5.6 ha respectively (Vilella 1995). Basic life history data are lacking for this species, so it is unknown whether home ranges or individual distributions shift between the breeding and nonbreeding periods (Vilella 2020). Nevertheless, the Cabo Rojo NWR and surrounding area may provide important foraging and roosting habitat for nightjars during the nonbreeding season; we believe that increased monitoring and spatial tracking efforts are warranted to better understand the movements and habitat use of this species throughout its annual cycle.

Our sightings could represent a recolonization of formerly occupied habitat in response to the regrowth of secondary forest (Raffaele et al. 2021). It is possible that the species was previously present in Cabo Rojo NWR and surrounding area but became locally extirpated due to anthropogenic landscape changes (e.g., habitat loss) or other factors (e.g., predation pressure due to introduced species such as mongoose; Raffaele et al. 2021). The fact that Puerto Rican Nightjars occur in other areas of the Cabo Rojo municipality (Castro-Prieto et al. 2021, Raffaele et al. 2021) suggests that our sightings represent a recolonization of previously occupied habitat.

Our observations could also be consistent with a range expansion, indicating that the distribution of Puerto Rican Nightjars is shifting, perhaps in response to climate-driven changes in habitat quality or suitability within the species' core range. In the aftermath of Hurricanes Irma (Category 5) and Maria (Category 4) in 2017, changes in site occupancy, occurrence, and detectability of various bird species were reported in Puerto Rico (Lloyd et al. 2019, Campos-Cerqueira and Aide 2021). Changes in site occupancy and detectability were also recorded in response to drought conditions in Puerto Rico during 2015–2016 (Campos-Cerqueira and Aide 2021). Population declines in several bird species after Hurricane Maria were also reported; for instance, the Endangered Puerto Rican Plain Pigeon (*Patagioenas inornata wetmorei*) declined by 88% (Marlier et al. 2022), and the Endangered Puerto Rican Parrot (*Amazona vittata*) may have declined by over 79% in El Yunque National Forest (Breining 2018). Thus, Puerto Rican Nightjars may have shifted their range in response to landscape-scale changes associated with hurricanes and/or drought conditions, which appear to be increasing in frequency and severity due to climate change; targeted research is needed to confirm this.

Although a recent island-wide population estimate is lacking for Puerto Rican Nightjars (González 2010, Vilella 2020, USFWS 2023), Kepler and Kepler (1972) estimated 450–500 breeding pairs in the Guánica Commonwealth Forest, based on the



**Fig. 1.** (A) Map of southwestern Puerto Rico with Cabo Rojo National Wildlife Refuge shown in the middle of the figure. Map credit: Google. (B) Map of Cabo Rojo National Wildlife Refuge and surrounding private property (Finca Altamira). Yellow circles indicate approximate locations where Puerto Rican Nightjars were observed. Locations are approximate to protect the specific sites at which this Endangered species was documented. Numbers within the circles indicate the locations referred to in the main text. Pink and purple lines indicate the Cabo Rojo National Wildlife Refuge boundary; orange lines indicate public trails. Map credits: O. Medina, Aly Ollivierre, Esri, and others.

assumption that each singing male detected had a mate. This estimate was later updated to 14,000–20,000 male nightjars distributed across ~10,000 ha, including Guánica-Ensenada, Susúa-Maricao, and Guayanilla-Peñuelas (Vilella and Zwank 1993, USFWS 2023). Not all singing birds are necessarily mated, and unmated male nightjars may sing more than mated males (Jackson 1984); thus, the assumption that every singing male represents a breeding pair likely results in overestimation of population size (Vilella and Zwank 1993). The recovery plan for Puerto Rican Nightjar states that the species should be considered for delisting following the establishment of 600 breeding pairs in Guánica Commonwealth Forest, 400 breeding pairs in

Guayanilla-Tallaboa region, and 200 breeding pairs in Susúa Commonwealth Forest (Díaz Díaz 1984, USFWS 2023). As none of these criteria have been met, Puerto Rican Nightjars remain listed as Endangered (USFWS 2023).

The primary threats to Puerto Rican Nightjars are habitat loss and degradation associated with anthropogenic activities such as land use intensification, including the expansion of road systems and development for housing, tourism, and industry (Vilella 2020, USFWS 2023). Predation, especially by introduced species, is an additional threat (USFWS 2023). Since 2017, new sightings of Puerto Rican Nightjars in the municipalities of Ponce and Guayama, and our sightings at the Cabo Rojo NWR, support past suggestions that the species is more widespread than previously documented (González 2010, Raffaele et al. 2021, USFWS 2023). However, only 14% of lands (155 km<sup>2</sup>) where Puerto Rican Nightjars are likely or confirmed to breed are formally protected (Castro-Prieto et al. 2021), such that the majority of nightjar habitat remains at risk, supporting the species' continued classification as Endangered (USFWS 2023).

Conservation is most effective when local communities are involved in and supportive of the conservation efforts being proposed (Rodríguez et al. 2007, Bennet et al. 2019, Dawson et al. 2021). Community science platforms such as eBird and the individual observations of birders and other community members have provided important contributions to knowledge of Puerto Rican Nightjar occurrence, distribution, and breeding status (Castro-Prieto et al. 2021, USFWS 2023). We encourage government and non-government organizations alike to continue partnering with local communities to promote the effective conservation of Puerto Rican Nightjars and other endemic species of Puerto Rico.

Available data suggest that establishing a network of protected habitat connecting both private and protected reserve lands is critical for Puerto Rican Nightjar persistence and recovery (González 2010, Vilella 2020). Future research should more systematically evaluate the distribution and abundance of Puerto Rican Nightjars in Cabo Rojo NWR and surrounding areas. If nightjars are more common in these regions than previously documented (i.e., due to regrowth of secondary forest throughout the Puerto Rican lowlands [Raffaele et al. 2021] and consistent with recent reports [Castro-Prieto et al. 2021, USFWS 2023]), we suggest that private and protected lands in Cabo Rojo with known nightjar detections be evaluated as potential areas for targeted management and conservation. Ultimately, with only an estimated 14% of Puerto Rican Nightjar breeding habitat under formal protection (Castro-Prieto et al. 2021), this species' recovery may hinge on safeguarding additional suitable habitat through land protection measures.

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### Author Contributions

LAG, QMM, and MJM made the field observations; LAG and MJM made the field recordings; JSQ provided research funding; LAG wrote the manuscript, and all authors contributed to editing manuscript drafts.

### Literature Cited

- Bennett N.J., A. Di Franco, A. Calò, E. Nethery, F. Niccolini, M. Milazzo, and P. Guidetti. 2019. Local support for conservation is associated with perceptions of good governance, social impacts, and ecological effectiveness. *Conservation Letters* 12:e12640.
- BirdLife International. 2016. *Antrostomus noctitherus*. The IUCN Red List of Threatened Species 2016:e.T22689809A93248623.
- Breining, G. 2018. How the Puerto Rican Parrot survived the devastating 2017 hurricane season. Living Bird. [allaboutbirds.org/news/how-the-puerto-rican-parrots-survived-the-devastating-2017-hurricane-season](http://allaboutbirds.org/news/how-the-puerto-rican-parrots-survived-the-devastating-2017-hurricane-season).
- Campos-Cerqueira, M., and T.M. Aide. 2021. Impacts of a drought and hurricane on tropical bird and frog distributions. *Ecosphere* 12:e03352.
- Castro-Prieto, J., J.M. Wunderle, Jr., J. Salguero-Farías, S. Soto-Bayó, J.D. Crespo-Zapata, and W.A. Gould. 2021. The Puerto Rico Breeding Bird Atlas. *USDA Forest Service General Technical Report no. IITF-53. Río Piedras, PR.*
- Danforth, S.T. 1936. *Los Pájaros de Puerto Rico*. Rand McNally and Company, New York.
- Dawson, N.M., B. Coolsaet, E.J. Sterling, R. Loveridge, N.D. Gross-Camp, S. Wongbusarakum, K.K. Sangha, L.M. Scherl, H. Phuong Phan, N. Zafra-Calvo, W.G. Lavey P. Byakagaba, C.J. Idrobo, A. Chenet, N.J. Bennett, S. Mansourian, and F.J. Rosado-May. 2021. The role of Indigenous peoples and local communities in effective and equitable conservation. *Ecology and Society* 26:19.
- Díaz Díaz, C.A. 1984. Recovery plan for the Puerto Rican whip-poor-will (*Caprimulgus noctitherus*). U.S. Fish and Wildlife Service, Atlanta, GA.
- eBird. 2023. eBird: Cabo Rojo NWR. [tinyurl.com/bdefeevp](https://tinyurl.com/bdefeevp).
- eBird: an Online Database of Bird Distribution and Abundance. eBird, Ithaca, NY.
- González, R.G. 2010. Population Estimation and Landscape Ecology of the Puerto Rican Nightjar. M.S. Thesis. Mississippi State University, MS.
- Grieves, L. 2021. eBird trip report. [ebird.org/tripreport/111245](https://ebird.org/tripreport/111245).
- eBird: an Online Database of Bird Distribution and Abundance. eBird, Ithaca, NY.
- Jackson, H.D. 1984. Capture/recapture data on the nightjars of Ranelia Farm, Zimbabwe. *Safring News* 13:43–50.
- Kepler, C.B., and A.K. Kepler. 1972. The distribution and ecology of the Puerto Rican Whip-poor-will, an endangered species. *Living Bird* 11:207–239.
- Lloyd, J.D., C.C. Rimmer, and J.A. Salguero-Farías. 2019. Short-term effects of hurricanes Maria and Irma on forest birds of Puerto Rico. *PLoS One* 14: e0214432.



- Marlier, M.E., S.A. Resetar, B.E. Lachman, K. Anania, and K. Adams. 2022. Remote sensing for natural disaster recovery: lessons learned from hurricanes Irma and Maria in Puerto Rico. *Environmental Science and Policy* 132:153–159.
- Quinn, J.S., and J.M. Startek-Foote. 2020. Smooth-billed Ani (*Crotophaga ani*), version 1.0. In *Birds of the World* (A.F. Poole and F.B. Gill, eds.). Cornell Lab of Ornithology, Ithaca, NY.
- Raffaele, H., J. Wiley, O. Garrido, A. Keith, and J. Raffaele. 1998. A Guide to the Birds of the West Indies. Princeton University Press, Princeton, NJ.
- Raffaele, H.A., C. Petrovic, S.A. Colón Lopez, L.D. Yntema, and J.A. Salguero Faria. 2021. Birds of Puerto Rico and the Virgin Islands. 3rd edn. Princeton University Press, Princeton, NJ.
- Reynard, G.B. 1962. The rediscovery of the Puerto Rican Whippoorwill. *Living Bird* 1:51–60.
- Robertson, J.K., J.R. Caldwell, L.A. Grieves, A. Samuelsen, G.S. Schmaltz, and J.S. Quinn. 2018. Male parental effort predicts reproductive contribution in the joint-nesting, Smooth-billed Ani (*Crotophaga ani*). *Journal of Ornithology* 159:471–481.
- Rodríguez, J.P., A.B. Taber, P. Daszak, R. Sukumar, C. Valladares-Padua, S. Padua, L.F. Aguirre, R.A. Medellín, M. Acosta, A.A. Aguirre, C. Bonacic, P. Bordino, J. Bruschini, D. Buchori, S. González, T. Mathew, M. Méndez, L. Mugica, L.F. Pacheco, A.P. Dobson, and M. Pearl. 2007. Globalization of conservation: a view from the south. *Science* 317:755–756.
- USFWS. 2023. Puerto Rican Nightjar or Guabairo (*Caprimulgus noctitherus*) 5-year status review: summary and evaluation. U.S. Fish and Wildlife Service Caribbean Ecological Services Field Office, Mayagüez, PR.
- USFWS. n.d. Cabo Rojo National Wildlife Refuge. U.S. Fish and Wildlife Service. [fws.gov/refuge/cabo-rojo/about-us](https://www.fws.gov/refuge/cabo-rojo/about-us).
- Vilella, F.J. 1989. The Reproductive Ecology and Population Biology of the Puerto Rican Nightjar *Caprimulgus noctitherus*. Ph.D. Thesis. Louisiana State University and Agricultural and Mechanical College, Baton Rouge, LA.
- Vilella, F.J. 1995. Reproductive ecology and behaviour of the Puerto Rican Nightjar *Caprimulgus noctitherus*. *Bird Conservation International* 5:349–366.
- Vilella, F.J. 2008. Nest habitat use of the Puerto Rican Nightjar *Caprimulgus noctitherus* in Guánica Biosphere Reserve. *Bird Conservation International* 18:307–317.
- Vilella, F.J. 2020. Puerto Rican Nightjar (*Antrostomus noctitherus*), version 1.0. In *Birds of the World* (T.S. Schulenberg, ed.). Cornell Lab of Ornithology, Ithaca, NY.
- Vilella, F.J., and P.J. Zwank. 1993. Geographic distribution and abundance of the Puerto Rican Nightjar (Distribución geográfica y abundancia del Guabairo Pequeño de Puerto Rico (*Caprimulgus noctitherus*)). *Journal of Field Ornithology* 64:223–238.
- Wetmore, A. 1916. Birds of Porto Rico. United States Department of Agriculture Bulletin 326:1–140.
- Wetmore, A. 1919. Description of a whippoorwill from Porto Rico. *Proceedings of the Biological Society of Washington* 32:235–237.
- Wetmore, A. 1922. Bird remains from the caves of Porto Rico. *American Museum of Natural History Bulletin* 46:297–333.