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Photo: Claudio Uribe

Desecheo Island: a new home for Audubon's Shearwaters (*Puffinus lherminieri*)

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Cover Page: Aerial view of Desecheo Island National Wildlife Refuge, seen from southwest in April 2016. Photograph by Claudio Uribe, Island Conservation.

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Abstract

Desecheo Island, located in Puerto Rico, is a National Wildlife Refuge (NWR) managed by the U.S. Fish and Wildlife Service (USFWS). In the past, Desecheo Island was a crucial seabird habitat. However, introducing invasive mammals led to the disappearance of many seabird species. In 2010, a collaboration between the USFWS and local partners began to implement a seabird restoration project in Desecheo. After successfully eradicating invasive mammals, the island was declared rat-free in 2017. After this, a seabird social attraction project started using different methods such as decoys, mirrors, and sound systems. An ongoing biosecurity program complements these efforts. During a visit to the island in 2023, we found an egg at the base of a social attraction speaker. A few days later, the site was revisited to deploy camera traps and collect feathers. The Smithsonian Feather Identification Laboratory confirmed the feathers to be from an Audubon's Shearwater (*Puffinus lherminieri*). This is the first-ever record of an Audubon's Shearwater nest on Desecheo Island. This discovery is a significant milestone in the project to restore seabird populations on the island. It also proves the success of the social attraction methods and showcases the benefits of an island free of invasive mammals. This is a positive step towards the conservation goal of restoring Desecheo Island into a safe haven for seabirds in the Caribbean.

Keywords

Audubon's Shearwater, Desecheo Island, invasive mammals, National Wildlife Refuge, *Puffinus lherminieri*, seabird restoration, social attraction

Resumen

Isla Desecheo: un nuevo hogar para *Puffinus lherminieri* • La isla Desecheo, ubicada en Puerto Rico, es un Refugio Nacional de Vida Silvestre (National Wildlife Refuge, NWR) gestionado por el Servicio de Pesca y Vida Silvestre de los Estados Unidos (United States Fish and Wildlife Service, USFWS). En el pasado, esta isla fue un hábitat crucial para las aves marinas. Sin embargo, la introducción de mamíferos invasores provocó la desaparición de muchas especies de aves marinas. En 2010, una colaboración entre el USFWS y socios locales comenzó la implementación de un proyecto de restauración de las poblaciones de aves marinas en Desecheo. En 2017, la isla fue declarada libre de ratas después de erradicar con éxito todos los mamíferos invasores. A partir de ese momento, se inició un proyecto de atracción social de aves marinas utilizando diferentes métodos como señuelos, espejos y sistemas de sonido, complementados con un programa de bioseguridad. Durante una visita a la isla en el 2023, encontramos un huevo en la base de un altavoz que forma parte del sistema de atracción social. Unos días después, se visitó nuevamente el sitio para instalar cámaras trampa y recolectar plumas. El Laboratorio de Identificación de Plumas del Smithsonian confirmó que las plumas pertenecían a un individuo de *Puffinus lherminieri*. Este es el primer registro de un nido de esta especie en la isla Desecheo y constituye un hito importante en el proyecto para recuperar las poblaciones de aves marinas en la isla. También demuestra el éxito de los métodos de atracción social y muestra los beneficios de una isla libre de mamíferos invasores. Este es un paso positivo hacia el objetivo de conservación de restaurar la isla Desecheo para que vuelva a convertirse en un refugio seguro para las aves marinas en el Caribe.

Palabras clave

atracción social, isla Desecheo, mamíferos invasores, *Puffinus lherminieri*, Refugio Nacional de Vida Silvestre, recuperación de aves marinas

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Résumé

L'île de Desecheo : un nouveau site pour les Puffins d'Audubon (*Puffinus lherminieri*) • L'île de Desecheo, située à Porto Rico, est une réserve nationale de faune sauvage (National Wildlife Refuge, NWR) gérée par l'U.S. Fish and Wildlife Service (USFWS). Par le passé, l'île de Desecheo était un habitat crucial pour les oiseaux marins. Cependant, l'introduction de mammifères invasifs a entraîné la disparition de nombreuses espèces appartenant à l'avifaune marine. En 2010, une collaboration entre l'USFWS et des partenaires locaux a permis de lancer un projet de rétablissement de ces populations d'oiseaux de cette île. Après l'éradication réussie des mammifères invasifs, l'île a été déclarée sans rats en 2017. Par la suite, un projet d'attraction sociale des oiseaux marins a démarré en utilisant différentes méthodes telles que des leurres, des miroirs et des repasses audio. Ces efforts ont été complétés par un programme de biosécurité toujours en cours. Lors d'une visite sur l'île en 2023, nous avons trouvé un œuf à la base d'un haut-parleur utilisé pour l'attraction sociale. Quelques jours plus tard, nous sommes retournés sur l'île pour installer des pièges photographiques et collecter des plumes. Le Smithsonian Feather Identification Laboratory a confirmé que les plumes étaient celles d'un puffin d'Audubon (*Puffinus lherminieri*). C'est la première fois qu'un nid de puffin d'Audubon est répertorié sur l'île de Desecheo. Cette découverte est une étape importante dans le projet de rétablissement des populations d'oiseaux marins sur l'île. Elle prouve également le succès des méthodes d'attraction sociale et met en évidence les avantages d'une île exempte de mammifères invasifs. Il s'agit d'une étape positive vers la restauration de l'île de Desecheo pour en faire un havre de paix pour les oiseaux marins dans les Caraïbes.

Mots clés

Attraction sociale, île de Desecheo, mammifères invasifs, National Wildlife Refuge, Puffin d'Audubon, *Puffinus lherminieri*, rétablissement de populations d'oiseaux marins

Desecheo Island is a 117-ha island located approximately 21 km off the northwest coast of Puerto Rico (Fig. 1). In 1976, Desecheo was designated a National Wildlife Refuge (NWR) and is one of nine refuges managed by the U.S. Fish and Wildlife Service (USFWS) in the Caribbean. The island consists of a peak of volcanic rock with sharp limestone rock edges (Wetmore 1918), and the highest point is 213 m above sea level (asl; USFWS 2012). The vegetation consists of a subtropical dry forest composed of a mosaic of open grasslands, shrubs, cacti, and semi-deciduous forest dominated by almácigo trees (*Bursera simaruba*) (Woodbury et al. 1971, USFWS 2012, Will et al. 2019, Herrera-Giraldo et al. 2021). Historically, Desecheo Island was an important habitat for seabirds in the Caribbean. In the early 20th century, seven seabird species were documented breeding on the island: Brown Booby (*Sula leucogaster*), Red-footed Booby (*Sula sula*), Brown Noddy (*Anous stolidus*), Bridled Tern (*Onychoprion anaethetus*), Sooty Tern (*Onychoprion fuscatus*), Laughing Gull (*Leucophaeus atricilla*), and Magnificent Frigatebird (*Fregata magnificens*), totaling tens of thousands of pairs (Wetmore 1918, Herrera-Giraldo et al. 2021). Brown Booby was the most abundant species, with estimates of up to 15,000 breeding individuals, making it one of the largest colonies in the Caribbean during the early 20th century (Wetmore 1918, USFWS 2012).

The introduction of feral goats (*Capra hircus*), black rats (*Rattus rattus*), cats (*Felis catus*), and rhesus macaques (*Macaca mulatta*) resulted in habitat loss and seabird predation, and the use of the island as a bombing range by the U.S. military (from WWII to 1952) also caused habitat loss (USFWS 2012, Herrera-Giraldo et al. 2021). Subsequently, five of the seven breeding seabird species disappeared from Desecheo, and the two species that remained breeding were decimated to 17 pairs of Bridled Terns and one pair of Brown Noddies, less than 2% of the historical population sizes (Herrera-Giraldo et al. 2021). A few other seabird species have been documented roosting on the island, such as Brown Boobies, Roseate Terns (*Sterna dougallii*), Cabot's Terns (*Thalasseus acutiflavus*), and Laughing Gulls, and there have been sporadic reports of Magnificent Frigatebirds, Red-billed Tropicbirds (*Phaethon aethereus*), and Audubon's Shear-

waters (*Puffinus lherminieri*) flying over the island (Herrera-Giraldo et al. 2021).

A recent eradication program for invasive mammals on Desecheo NWR was successfully implemented from 2008 to 2016, through a collaboration between the USFWS and the non-profit organization Island Conservation (IC; J.C. Herrera, C. Figuerola, and D. Will 2017, unpubl. report). The island was declared free of invasive mammals in 2017. Following the eradication, the USFWS, IC, and the non-profit organization Effective Environmental Restoration, Inc. (EER) collaborated to establish biosecurity and social attraction projects to maintain the island rat-free and to re-establish seabird breeding colonies on Desecheo NWR.

The Audubon's Shearwater is distributed in the tropical and subtropical western Atlantic Ocean (Kirwan et al. 2020). It is the least known of all Caribbean seabird species (Mackin 2016) and characterized by its nest site fidelity. In the Caribbean, it tends to nest in cavities and under dense vegetation (Mackin 2016). The species' annual cycle includes egg-laying in February and fledging in June in the Lesser Antilles (Mackin 2016). The Caribbean population is considered small, with estimates of 3,000–5,000 breeding pairs at 62 extant and extirpated sites (van Halewyn and Norton 1984, Mackin 2016) and as low as 2,700 at 111 sites (Bradley and Norton 2009). In Puerto Rico, it breeds in Lobo, Del Agua, Luis Peña, Yerba, and Ratón Cays in the Culebra archipelago and on Mona Island (Castro-Prieto et al. 2021, Figuerola-Hernandez et al. 2021). The species has disappeared from some former breeding sites and is classified as Near Threatened (Lee 2000).

A combination of three social attraction methods have been implemented for restoring seabird colonies on Desecheo NWR: polyethylene plastic decoys, mirrors (30 × 15 cm) for Bridled Terns and Brown Noddies, and sound systems composed of one 240-watt Pyle amplifier, a charge controller, and an MP3 player. Two sound systems are situated on the island's southwestern coast, 250 m apart. Each sound system has two outdoor speakers, four solar panels, and two deep-cycle marine batteries. The speakers are placed ~20 m apart. The audio range for each

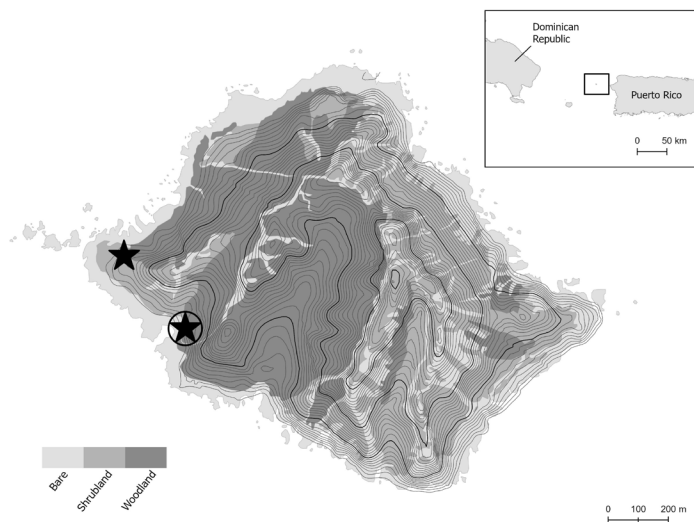


Fig. 1. Vegetation and contour map of Desecheo National Wildlife Refuge. Stars indicate location of sound systems; the star with the circle indicates where the egg was found. 5-m contour lines are shown. Inset shows location of the island west of Puerto Rico. Modified from Will *et al.* 2019.

system is estimated to be between 300–500 m, depending on surrounding noise, such as boats and waves, simulating the expected sound level of an active breeding colony. The sound systems are programmed to play the sounds of an Audubon's Shearwater colony for 12 h of every 24 h from dusk to dawn (Herrera-Giraldo *et al.* 2021). The social attraction sound system for Audubon's Shearwater was deployed in 2017 as part of the efforts to increase the population of native seabirds after the eradication of invasive mammals.

Observations

The first record of Audubon's Shearwater on motion-sensing cameras was on 17 April 2018 on top of one speaker (Fig. 2B). The equipment is located on the western side of Desecheo Island. In 2019, two individuals of Audubon's Shearwater were recorded with a motion-sensing camera (Browning Strike Force, Browning, Morgan, UT, USA and Reconyx PC900 Hyperfire Professional IR motion sensors, Reconyx, Holmen, WI, USA; Fig. 2A) on top of the same speaker as in 2018 (Fig. 2C). The records were on two different dates (16 February and 11 June 2019). Site visits in 2018 and 2019 were also conducted, and no signs of nesting activity were observed.

On 21 February 2023, during a biosecurity inspection, a single white egg was found at the base of a speaker located 250 m away from the other speaker where the Audubon's Shearwaters were observed in previous years (Fig. 3). This speaker is in the southwest of Desecheo Island and is part of the second sound system (Fig. 1). The white egg was alone; no adult was incubating the egg or at the nest, but there were fresh feces. We did not measure egg parameters. Another visit to the island was made on 2 March 2023 to deploy three motion-sensing cameras near the nest, but the egg was not found. We searched an approximate area of 10 m in diameter around the speaker for any bird signs (feces, feather, egg). No egg or shell was found, but a few

black and white feathers were found and collected where the egg was previously sighted. The Smithsonian Feather Identification Laboratory used a combination of methods to identify the feathers, including DNA barcoding using the cytochrome c oxidase subunit I gene (CO1), feather microscopy, and comparing the 152 whole feather samples with possible species of birds in Puerto Rico. The feather samples matched perfectly with Audubon's Shearwater (Fig. 4).

On the motion-sensing cameras, one individual Audubon's Shearwater was recorded several times next to the speaker where the egg was documented (Fig. 5). Two cameras recorded one Audubon's Shearwater visiting the speaker for 12 days, between 2 March and 18 March and between 1900–0630.

Discussion

On Desecheo Island, several positive outcomes have been documented after the invasive mammal eradications, including an increase in the native cactus *Harrisia portoricensis* (Figuerola *et al.* 2017), arthropods such as butterflies, grasshoppers, and crabs (Shiels *et al.* 2017), and seabird nesting, particularly Bridled Terns (Island Conservation, unpubl. report). Our observations in February 2023 mark the first ever Audubon's Shearwater nest registered for Desecheo Island. The first time the species was documented on the island was in 2018, and five years after, a nest was documented. Five to eight years is the estimated age of first breeding of Audubon's Shearwater (Snow 1965, Mackin 2009). Since the egg was not found on our next visit nine days later, we have no evidence of the cause of disappearance. The ongoing biosecurity program confirms that the island continues to be rat-free; the only remaining invasive species is the green iguana (*Iguana iguana*). There is debate on the diet of green iguanas; some consider it may be opportunistically omnivorous

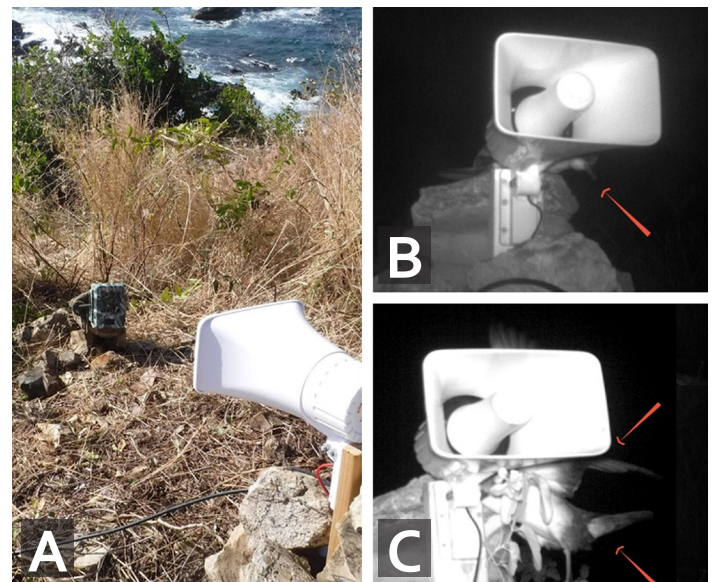


Fig. 2. (A) Speaker and motion-sensing camera that detected the first Audubon's Shearwater individuals. (B) First record of Audubon's Shearwater individual perched on top of the social attraction speaker in April 2018. (C) Two individuals perched on top of the speaker in June 2019. Photographs by Island Conservation.



Fig. 3. Egg found at the base of a social attraction speaker in the southwest of Desecheo Island on 21 February 2023. Photograph by José Armando Valentín (EER).

(Govender *et al.* 2012), others conclude that there is no proof that green iguanas predate on eggs (Arce-Nazario and Carlo 2012). Human intervention is another possibility; although the island is closed to the public, visits have been reported.

Desecheo could become a new safe nesting habitat for Audubon's Shearwater, augmenting the regional population size. However, we expect the establishment of an Audubon's Shearwater breeding colony to be slow given that breeding adults are



Fig. 4. Feather samples collected from the nest matched perfectly with Audubon's Shearwater. Photograph by Dr. Carla Dove.

typically site-faithful, leaving younger prospecting birds as the primary colonizers likely to respond to social attraction stimuli (Herrera-Giraldo *et al.* 2021). While the results are promising and indicate that sound systems do attract Audubon's Shearwater, additional interventions are being considered to augment the likelihood of nesting, such as the establishment of artificial nests in areas of rocky shore vegetation (Correll and Correll 1982) and under dense vegetation (Mackin 2016). Desecheo Island presents natural cavities around the coastal perimeter that should be monitored during the breeding season since other populations of the Audubon's Shearwater in the Caribbean nest in caves and crevices (Bretagnolle and Precheur 2012). The nearest known breeding site is Mona Island, 49 km away from Desecheo Island. Figuerola *et al.* (2021) reported Audubon's Shearwater nesting there in a cave, representing the first documented evidence of breeding activity since 1937 (Smyth 1938). The status of the population on Mona Island is poorly known because it is likely that the species is only nesting in caves that are difficult to access and thus poorly surveyed. These caves probably provide a safe refuge to the species that would otherwise be extirpated from the island by rodents and feral cats (Figuerola *et al.* 2021).

Although we are in the early stages of anticipating a healthy population of the Audubon's Shearwater on Desecheo Island, this first documented active nesting activity provides a positive step towards continuing with the biosecurity measures, strengthening the social attraction methods, providing artificial alternatives for nesting, and implementing standardized monitoring protocols for seabirds as other populations are slowly augmenting on the island. The conservation goal of restoring Desecheo Island to a safe breeding location for Caribbean seabirds will continue through management actions focused on improving seabird breeding habitat.

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Fig. 5. Audubon's Shearwater individual detected with a motion-sensing camera next to the speaker where the egg was found (March 2023). Photograph by Island Conservation.

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Author Contributions

JLH and CFH installed the social attraction sound system for the Audubon's Shearwater; LRV, NAH, and JLH monitored the nest, deployed and recovered motion sensing cameras; EVF recorded the egg; LRV sent the feather for identification; LRV and NAH wrote the manuscript, and all of the authors contributed editing the manuscript drafts.

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