

The use of social attraction techniques to restore seabird colonies on Desecheo Island, Puerto Rico

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Abstract

1. Desecheo Island (117 ha) was historically an important seabird island in the Caribbean with 15 species recorded, of which seven are known to breed, including major populations of brown boobies and red-footed boobies. The introduction of invasive mammals, plus the use of the island as a bombing range, contributed to the extirpation of five of the seven known breeding populations of seabird species and vastly reduced numbers of the remaining two species. The island became a National Wildlife Refuge in 1976 and major conservation interventions have included the eradication of invasive goats, rhesus macaques and rats between 1976 and 2016. Removing these critical threats from the island has allowed other active restoration goals to be realized, including restoring seabird colonies to the island.
2. Here, we report on the installation of social attraction equipment in 2018 to augment bridled tern and brown noddy colonies and establish a species of conservation concern, the Audubon's shearwater. We supported these actions through a review of historic seabird nesting and roosting on Desecheo. Motion-sensing cameras were installed to document activity at each social attraction site and evaluate the effectiveness of our methods.
3. During the 2 years of deployment and monitoring, a total of seven bridled tern nests were documented in new and historic sites for the species, two of them next to a decoy colony; however, no brown noddy visits or nests were detected. In 2018 and 2019, one and two Audubon's shearwaters, respectively, were attracted to one of the sound system speakers, representing the first record for this species on the island.
4. Social attraction efforts on Desecheo appears to be a feasible activity that may help support seabird recolonization and support conservation goals for this National Wildlife Refuge.

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KEYWORDS

Audubon's shearwater, bridled tern, brown noddy, Desecheo Island, invasive species, restoration, seabirds, social attraction

1 | INTRODUCTION

Seabirds represent the most threatened group of birds globally (Croxall et al., 2012), with impacts from introduced mammals driving population reduction and extirpation globally (Spatz et al., 2017). Desecheo Island (177 ha; elevation 218 m) is a National Wildlife Refuge (NWR) administered by the U.S. Fish and Wildlife Service (USFWS) and is located approximately 21 km off the northwest coast of the Commonwealth of Puerto Rico (-18.384° N; -67.480° W). The island has a sub-tropical dry forest dominated by the semi-deciduous almacigo tree (*Bursera simaruba*) mixed with cacti, shrubs and open grasslands.

Desecheo was historically an important seabird rookery in the Caribbean with 12 seabird species recorded in the 20th century, including seven known breeding species (Bowdish, 1900; Meier et al., 1989; Noble & Meier, 1989; Schaffner, 1993a, 1993b, 1993c, 1993d, 1993e, 1993f, 1993g; Struthers, 1927; Wetmore, 1918). Brown boobies (*Sula leucogaster*) were the most abundant species with estimates between 8000 and 15,000 breeding individuals per year (Danforth 1931, as cited in Meier et al., 1989; Wetmore, 1918), making it at one time one of the largest colonies in the Caribbean region (USFWS, 2015). In addition, about 10,000 red-footed boobies (*Sula sula*) were reported in 1927 (Danforth, 1931, as cited in Noble & Meier, 1989). Likewise, observations included more than 2000 brown noddy (*Anous stolidus*), 1500 bridled terns (*Onychoprion anaethetus*), hundreds of magnificent frigatebirds (*Fregata magnificens*), hundreds of laughing gulls (*Leucophaeus atricilla*) nesting on Desecheo and offshore islets (Struthers, 1927; Wetmore, 1918) and 34 sooty terns (*Onychoprion fuscatus*) nests (Bowdish, 1900).

The introduction of invasive mammals to Desecheo, including black rats (*Rattus rattus*) (estimated during European arrival in the 15th century), feral goats (*Capra hircus*) (in 1788), cats (*Felis catus*) (in 1966) and rhesus macaques (*Macaca mulatta*) (in 1966), as well as the use of the island as a bombing range (from WWII to 1952), negatively affected seabirds through habitat loss and predation (Evans, 1989; Meier et al., 1989; Morrison & Menzel, 1972; Noble & Meier, 1989; Raffaele, 1973; Struthers, 1927; Wetmore, 1918). Consequently, few recent records of seabirds nesting and roosting exist for the island. Since 2008, five of the seven historic breeders are considered extirpated (historic populations once ranged from 3 to 15,000; Table 1), with the most remarkable decline being the brown booby that went from 15,000 breeding individuals (in 1931) to zero in just 60 years (Noble & Meier, 1989). The remaining two breeding seabirds, brown noddy and bridled tern, breed in vastly reduced numbers (i.e. less than 2% of the historical breeding populations) and primarily on offshore rock stacks (Wolf et al., 2010). Thus, the island's seabird population is now limited to small numbers of nesting and roosting bridled terns and

brown noddies: roosting brown boobies, roseate terns (*Sterna dougallii*), sandwich terns (*Thalasseus sandvicensis*) and laughing gulls; and occasional reports of magnificent frigatebirds (*Fregata magnificens*), white-tailed tropicbirds (*Phaethon lepturus*), red-billed tropicbirds (*Phaethon aethereus*) and Audubon's shearwaters (*Puffinus lherminieri*) flying over the island (A. Morales-Pérez 2008, 2010 and 2016 unpubl. ms.; Island Conservation, 2013; McKown, 2009; Wolf et al., 2010). Between 2010 and 2017, a partnership between USFWS and the non-government organization Island Conservation (IC) successfully removed invasive mammals from Desecheo with a goal to protect and restore the island ecosystem, with emphasis on native seabirds, endemic reptiles and native plants.

Seabird restoration programs aim to re-establish extirpated populations as well as augment existing populations (Jones & Kress, 2012). Implementing seabird restoration methods after an invasive mammal eradication is a good opportunity to speed up this process (Kappes & Jones, 2014). On Desecheo, our objectives were to initiate social attraction methodologies to (a) augment numbers of bridled terns and brown noddies and (b) establish Audubon's shearwaters, consistent with USFWS intent to restore seabird colonies in the NWR. At a regional scale, securing seabirds on Desecheo also offers a potentially valuable high-elevation refuge from projected sea level-rise impacts.

2 | MATERIALS AND METHODS

2.1 | Site and species selection

We conducted an extensive literature review of historic and recent seabird species records for Desecheo Island to guide where seabird restoration could be considered. Historic records were defined as occurring in the 20th century and recent records occurred in the 21st century. The primary resource for our literature review was the USFWS Caribbean Islands National Wildlife Refuge Complex Library, where both internal and public reports are digitized and filed. In addition to this, we conducted an internet search using Google and Google Scholar using the search terms "Desecheo" and "seabird" as well as reviewed internal reports from past field trips to the island completed by Island Conservation staff. For each report or article, we collected the following information: behaviour (breeding or roosting), number of individuals or nests observed, location on island and the reference (author and year). Location data varied in quality and specificity; therefore, some general descriptions were interpreted by individuals most familiar with the island. With this information, we used ArcMap software (version 10.3.1, ArcGIS) to create polygons delimiting the areas where seabirds were reported and created a location map for each documented seabird species.

TABLE 1 Historic (1900–1999) and recent (2000–2019) data for 15 seabird species documented on Desecheo Island and its offshore islets: BRBO (brown booby), RFBO (red-footed booby), BRNO (brown noddy), BRTE (bridled tern), LAGU (laughing gull), MAFR (magnificent frigatebird), SOTE (sooty tern), ROYT (royal tern), LETE (least tern), ROST (roseate tern), BRPE (brown pelican), WTTR (white-tailed tropicbird), RBTB (red-billed tropicbird), SATE (sandwich tern) and AUSH (Audubon's shearwater)

Historic					Recent			
Species	Behaviour	Number	Number Type	Year	Behaviour	Number	Number Type	Year
BRBO	Breeding	15,000	Individuals	1927	Roosting	100	Individuals	2009
RFBO	Breeding	10,000	Individuals	1927	—	—	—	—
BRNO	Breeding	2000	Individuals	1912	Breeding	1	Nest	2010
BRTE	Breeding	1500	Individuals	1912	Breeding	17	Individuals	2010
LAGU	Breeding	700	Individuals	1970	Roosting	2	Individuals	2009
MAFR	Breeding	300	Individuals	1922	Flying over	11	Individuals	2013
SOTE	Breeding	34	Nest	1900	—	—	—	—
ROYT	Roosting	1	Individual	1993	—	—	—	—
LETE	Roosting	1	Individual	1993	—	—	—	—
ROST	Roosting	1	Individual	1993	Roosting	80	Individuals	2008
BRPE	Unspecified	1	Individual	1987	—	—	—	—
WTTR	Flying over	>1	Individuals	1901	Flying over	2	Individuals	2010
RBTB	—	—	—	—	Flying over	1	Individual	2016
SATE	—	—	—	—	Roosting	20	Individuals	2008
AUSH	—	—	—	—	Roosting	2	Individuals	2019

Note: The number listed represents the highest reported of individuals for each species including behaviour and year of observation.

Of the 15 (12 documented historically, plus three recorded after 2008) species identified through the literature review, we prioritized the restoration of three species' breeding populations: bridled tern, brown noddy and Audubon's shearwater. All three species are small (<300 gm), with ground- or burrow-nesting breeding behaviour, and thus, expected to have been most impacted by multiple introduced, invasive mammal species on Desecheo (Jones et al., 2008, 2018; Medina et al., 2011). In addition, we expected bridled tern and brown noddy populations to have a higher probability of responding to social attraction tools given that both species have been previously observed attempting to nest in low numbers on the island and on rock stacks offshore of Desecheo and in the nearby Mona channel, meeting necessary assumptions of a nearby source population to interact with any stimuli (Buxton et al., 2014). While we did not find published examples of social attraction projects for noddy species or specifically bridled terns and Audubon's shearwaters, successes have been proven at the family level. Terns (family Laridae) are known to respond well to seabird restoration methods, a function of flexible breeding behaviour and low fidelity to breeding sites (Jones & Kress, 2012). Similarly, shearwater species have been demonstrated to respond well to acoustic social attraction techniques elsewhere (Jones & Kress, 2012); however, we had greater uncertainty about an Audubon's shearwater source population to interact with the social attraction stimuli as no individuals were known to breed on Desecheo. Calling activity was detected on the southwest coast of the island in 2012 (Island Conservation, 2013). The nearest known source population is 80 km southwest on Mona Island (C. Figuerola-Hernández pers. comm., Dec 2020). How-

ever, the Caribbean population of the Audubon's shearwater is small; the species has disappeared from a number of former breeding sites, mainly due to predation by invasive species like rats and feral cats, and has been classified as Near Threatened by Schreiber and Lee (Lee, 2000), making this species a conservation priority for the region (Bradley & Norton, 2009).

Using the maps created for bridled tern and brown noddy, we identified three and two potential social attraction sites, respectively, where there was evidence of historic breeding, and we could safely access the site with appropriate equipment. For the Audubon's shearwater, we utilized observations from the 2013 seabird monitoring trip to identify two social attraction sites with habitat similar to the species' nesting sites on other Caribbean islands (W. Mackin pers. comm., Oct 2017) and could be safely accessed and monitored over time by personnel (Figure 1). Beyond logistical considerations, the selection of the two sites was based on (1) prioritizing the area where the species had been heard calling while flying over at night in 2013 and (2) finding suitable nesting habitat for the species on the west coast of the island where calling was detected.

2.2 | Equipment

Using a mix of audio and visual cues, we employed three social attraction methods for restoring seabird colonies on Desecheo Island: decoys, mirrors and sound systems. For bridled tern and brown noddy, recycled high-density polyethylene plastic decoys were manufactured

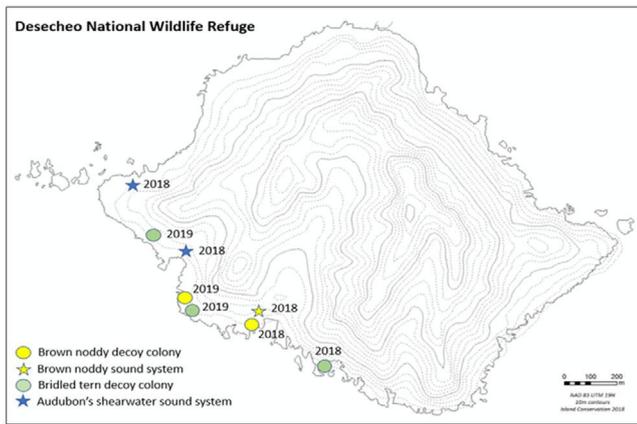


FIGURE 1 Locations of social attraction techniques for three seabird species on Desecheo Island. Each colony and sound system present the year of establishment

and painted by The National Audubon Society. The decoys were a 1:1 size scale and were placed both as individuals and in pairs, simulating roosting and nesting behaviour, facing the ocean. All decoys were glued to the rock using high-strength anchoring epoxy (Figure 2). Mirrors were approximately 30 cm in height and 15 cm in width and directed at decoys to create a visual effect of a larger colony. Sound systems were manufactured by the National Audubon Society and consisted of one 240-watt Pyle amplifier, a charge controller and a mp3 player as the main components of the sound system (Figure 3). In addition, each sound system had two outdoor speakers, four solar panels and

two deep-cycle marine batteries. The speakers were placed approximately 20 m apart from each other. The amplifier unit maximized the sound output of the recordings, which were collected from natural Audubon's shearwater and brown noddy colonies in the Caribbean. The audio range for each system was estimated to be between 300 and 500 m, depending on surrounding noise such as boats and waves, simulating the expected sound level of an active breeding colony. Two sound systems were programmed to play the sounds of an Audubon's shearwater colony for 12 of every 24 h from dusk to dawn, and one sound system was programmed to play the sounds of a brown noddy colony for 12 of every 24 h from dawn to dusk. To monitor responses, we deployed one to four motion-sensing cameras (Reconyx PC900 Hyperfire Professional IR and/or Browning Strike Force Elite HD) at each decoy colony site and two cameras – one directed on each speaker – at sound system sites.

2.3 | Bridled tern

In February 2018, we deployed 30 bridled tern decoys, five mirrors and five motion-sensing cameras at one site on the south of the island, covering 192 m² total area (Figures 2a and 2b). In March 2018, a large storm surge hit Desecheo and 29 out of 30 bridled tern decoys were lost, as well as all the mirrors and cameras. In February 2019, we removed the single remaining decoy and established two new decoy colonies on the west coast, one with 30 decoys, five mirrors and three cameras and the second with 32 decoys, five mirrors and two cameras.



FIGURE 2 The seabird decoy colonies on Desecheo Island: (a) bridled tern; (b) bridled tern decoys with mirrors; (c) brown noddies with a speaker; (d) brown noddies with a mirror



FIGURE 3 The seabird sound systems on Desecheo Island: (a) solar-powered system; (b) sound system; (c) outdoor speaker with motion-sensing camera pointing towards it; (d) Brown noddy decoy and speaker arrangement

2.4 | Brown noddy

In February 2018, we deployed 18 brown noddy decoys, three mirrors and five motion-sensing cameras at one site on the south side of the island (Figures 2c and 2d). In addition, we deployed a sound system with accompanying cameras 30 m north of the decoy colony (Figures 3c and 3d). Cameras at the sound system site were deployed from February to September in both 2018 and 2019. In March 2019, we added a second decoy colony of 10 brown noddy decoys on a rock outcrop on the west coast with two cameras and no mirrors.

2.5 | Audubon's shearwater

In February 2018, we placed two sound systems with motion-sensing cameras on the western coast of the island 250 m apart (Figure 1). Cameras were deployed from February to September 2018 and February to August 2019.

3 | RESULTS

3.1 | Historic breeding knowledge

Based on our literature review, we found and reviewed a total of 35 manuscripts and internal and public reports and summarized 71 descriptions of seabirds nesting, roosting or flying near Desecheo Island. We created location maps for the 12 seabird species for which

we found a historic or recent record of active breeding or roosting on the island: brown booby, brown noddy, bridled tern, laughing gull, red-footed booby, magnificent frigatebird, sooty tern, royal tern, least tern, roseate tern, sandwich tern and Audubon's shearwater (Figures 4a and 4b). The remaining three of the 15 total species recorded for the island were only documented over the waters surrounding Desecheo Island. Since no island-specific location information was available, we did not create corresponding maps; these were white-tailed tropicbird (*Phaethon lepturus*), red-billed tropicbird (*Phaethon aethurus*) and brown pelican (*Pelecanus occidentalis*). This does not mean these species never bred on Desecheo, only that we found no record. We divided records into two categories – recent (data collected from 2000 to 2019) and historic records (data collected before 2000) (Table 1). We could not determine if Audubon's shearwater had previously bred on the island. Individuals had been observed flying offshore and occasionally heard calling over the island at night in 2012 (Island Conservation, 2013) but no other potential nesting activity was documented. Between March and April 2013, analysis of 146 h of automated acoustic recordings (using Wildlife Acoustic Songmeters SM4) did not yield any detected calls.

3.2 | Bridled tern social attraction project

Unfortunately, in 2018, due to the March storm surge, mirrors and cameras as well as 29 of the 30 decoys were only deployed for approximately 3 weeks. In June 2018, we returned to the island and documented two nests each with an egg on the south side of the island

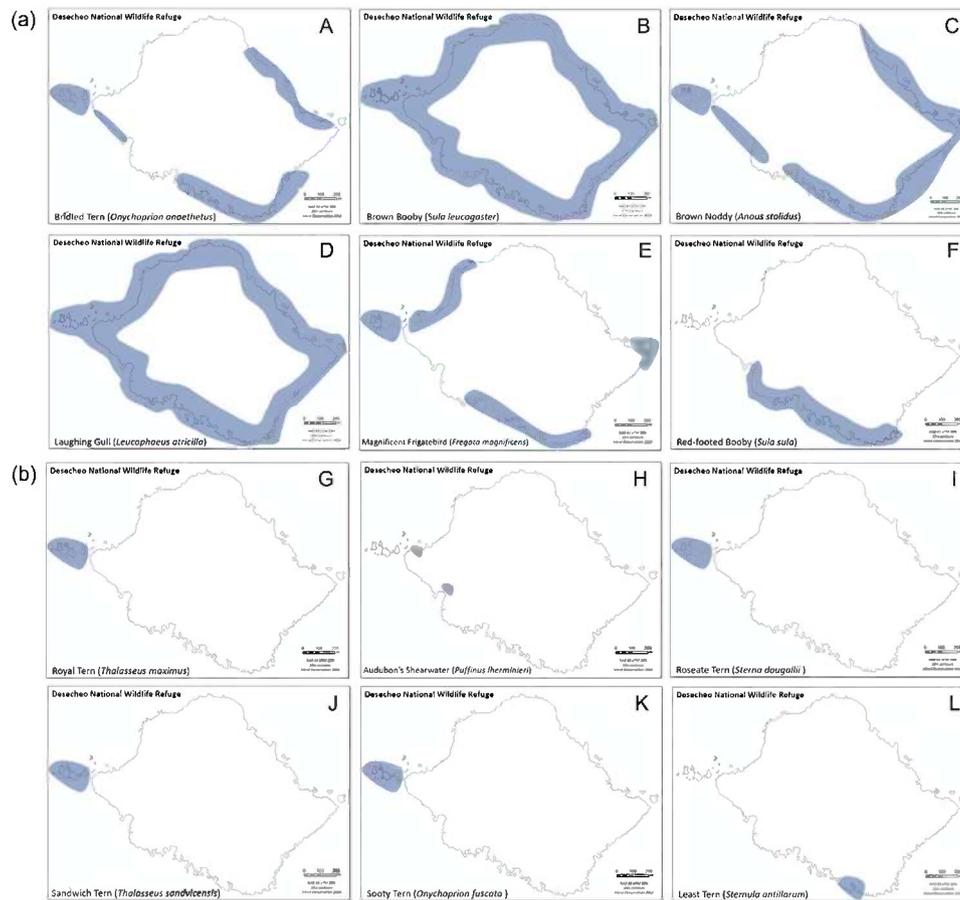


FIGURE 4 (a) Observations of roosting or breeding for 12 seabird species documented on Desecheo Island: (A) bridled tern, (B) brown booby, (C) brown noddy, (D) laughing gull, (E) magnificent frigatebird and (F) red-footed booby; (b) Observations of roosting or breeding for 12 seabird species documented on Desecheo Island: (G) royal tern, (H) Audubon's shearwater, (I) roseate tern, (J) sandwich tern, (K) sooty tern and (L) least tern



FIGURE 5 Bridled tern activity at the decoy colony established in 2018 on the south end of Desecheo Island: (a) two individuals perched next to one decoy; (b) nest with one egg near the decoy colony found in June 2018

adjacent to where the decoy colony had been placed (Figure 5a). A third nest was observed in a cliff on the south side of the island, but the presence of an egg was not confirmed. Camera monitoring was undertaken from June 2018 to January 2019 producing 330 images over 200 days and documented bridled tern activity at the decoy colony from June to August 2018, showing individuals perching and flying next to one

decoy (Figure 5b). Invasive green iguanas (*Iguana iguana*) were documented on camera as well walking by the decoy during the same period. Approximately 86% of the photos were invasive green iguanas, 5.5% were bridled terns and 8.5% were leaves moving around the decoy.

Four months following the February 2019 decoy colony deployments, we visited the island and found no nests. Camera monitoring

was undertaken from February to August 2019 producing 5461 images and 47 videos over 128 days. A review of all images found no bridled terns nesting or roosting at these sites. Thus, no bridled tern individuals were documented in these two 2019 decoy colonies located on the west coast of the island; however, five nests were found in an area distinct from the decoy colonies (approximately 215 m) but also on the west side of the island.

3.3 | Brown noddy social attraction project

The brown noddy social attraction equipment was undamaged in the March 2018 storm. We conducted a total of 12 checks of the brown noddy decoys and sound system, with both remaining fully functional through our last check in August 2019. Camera monitoring was undertaken from February to August 2018 at the decoy colony producing 8000 images in over 210 days. In 2019, camera monitoring was conducted from January to August at the original 2018 site plus the second decoy colony on the southwest side of the island, producing 8500 images over 210 days. A review of all images found no brown noddies nesting or roosting at these sites. However, during visits to the island, we observed one brown noddy flying near the decoy colonies and up to three individuals flying around the island.

3.4 | Audubon's shearwater social attraction project

The Audubon's shearwater sound systems were undamaged in the March 2018 storm. We visited the island five times to check the sound systems and change camera batteries, which remained fully operational from the February 2018 deployment through our last check in August 2019. Camera monitoring from February to September 2018 produced 81,476 images over 112 days. A review of all images found one Audubon's shearwater individual regularly roosting on top of one of the sound system speakers between April and June 2018 (Figure 6a). In 2019, we conducted camera monitoring from February to August and documented a single individual visiting the same speaker from February to June and two individuals visiting that speaker in June, showing either an attempted copulation or aggressive interaction (Figure 6b). We conducted nest searches around the sound system sites in September 2018 and August 2019 and did not find any nests.

4 | DISCUSSION

The introduction of non-native invasive mammals to islands has had dramatic consequences to seabirds globally (Dias et al., 2019; Jones et al., 2008; Spatz et al., 2014) and is identified as a key threat to seabird colonies in the Caribbean (Bradley & Norton, 2009). Our literature review shows a decline in total abundance of seabirds and number of breeding seabird species on Desecheo in the 20th century (Table 1), during which invasive mammals including rats (present from

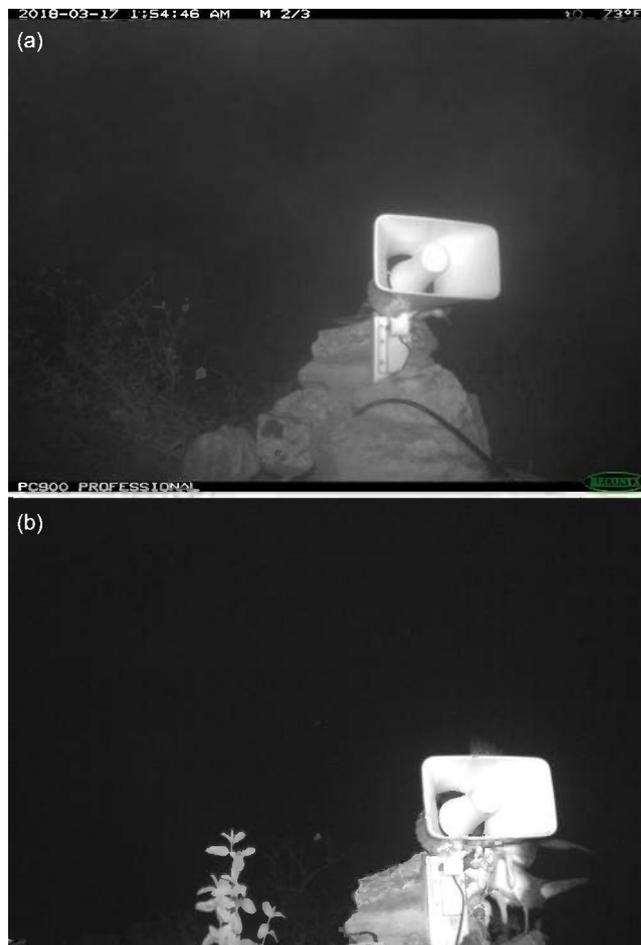


FIGURE 6 (a) First records of an Audubon's shearwater on Desecheo Island: individual perching on sound system speaker in April 2018. (b) two individuals documented in June 2019

~1400s to 2016) and goats (present from 1788 to 2010) were present, rhesus macaques were introduced (1966 to 2015) and the island was used as a bombing range (1940–1960). Following cessation of bombing and subsequent designation as a NWR in 1976, managers eradicated damaging invasive and non-native rats, goats and macaques from Desecheo to support biodiversity conservation goals and enable other restoration techniques, as seen elsewhere around the world (Jones et al., 2016). On Desecheo Island, several positive outcomes were documented following invasive mammal eradication, including an increase in the native cactus *Harrisia portoricensis* (Figuro, 2017) and arthropods such as butterflies, grasshoppers and crabs (Shiels et al., 2017). However, seabird response was limited, with no observed changes in the number of bridled tern or brown noddy breeding pairs across the island (Island Conservation, 2013; McKown, 2009; Wolf et al., 2010). Our seabird restoration efforts were intended to expand the bridled tern and brown noddy breeding populations and increase the likelihood of Audubon's shearwaters becoming established on Desecheo. Resource availability did not allow us to utilize either a spatial or temporal control to compare results, limiting our ability to infer results. Nonetheless, documenting our approach, challenges

and initial observations is beneficial to conservation practitioners and others seeking to support seabird conservation.

Prior to our project, in 2010, bridled terns were observed breeding on the offshore rocks (thirteen nests) and in small numbers (four nests) on the main island of Desecheo, and one brown noddy nest had been documented on the main island (Table 1). Their presence provided a potential source population to interact with our decoys and support creation of new roosting and nesting sites. We saw evidence of bridled terns interacting with decoys; however, nesting has not yet increased significantly across the island (bridled tern main island nests observed: pre-social attraction implementation (2010) 4 and (2013) 0 and post-social attraction implementation (2018) 3 and (2019) 5), suggesting it has been the local Desecheo population responding to the techniques used (with possibly one recruited pair) and more years of social attraction will be required to increase the likelihood of new individuals (i.e. not from Desecheo) interacting with the social attraction stimuli. Despite the absence of brown noddy nesting activity near the decoy colonies or sound system, individuals were observed flying near the southern side of the island, confirming the continued presence of this species on the island. And while Audubon's shearwater activity is a first for the island, no active nesting has yet been found. Given the methodology has only been implemented for 2 years, and age of first breeding is estimated to be 3–5 years for bridled tern, 3–7 years for brown noddy and 5 years for Audubon's shearwater, it is not surprising that we recorded no interaction from brown noddies and only small numbers of bridled terns and Audubon's shearwaters interacting with the social attraction stimuli (Labbé, 2017; Mackin, 2007; USFWS, 2016). Further, relatively small regional population sizes limit the likelihood of interactions, with Hispaniola and Puerto Rico estimates of brown noddy to be <1500 pairs, <700 bridled terns (Keith, 2009; Saliva, 2009) and <1500 of Audubon's shearwaters (Mackin, 2016), with a smaller proportion of these numbers occurring in the Hispaniola Channel where Desecheo occurs. Thus, we expect having the social attraction stimuli in place for more years will increase the likelihood of more individuals from the regional population encountering and interacting with the stimuli.

Prior to our project, there was no direct evidence of Audubon's shearwater nesting on Desecheo but if they were, they would have been at high risk of extirpation via invasive mammals. Given this species is resident in the Hispaniola Channel, including breeding on nearby Mona Island (C. Figuerola-Hernández pers. comm., Dec 2020), and the availability of potential burrow sites, it is reasonable to presume they once bred on Desecheo. This species is a conservation priority for the Caribbean region and securing a population on Desecheo would provide important nesting habitat for the species. Our documentation of the Audubon's shearwater visiting Desecheo (March 2018) as well as two individuals interacting with each other in an unconfirmed behaviour (June 2019) provides evidence that the attraction of a breeding population of this species is feasible.

During the social attraction deployment period, we lost decoys to storm wash and observed a potential new threat of invasive green iguanas. Despite deploying bridled tern decoys on a 20-m high cliff ledge perceived to be out of reach, decoys were washed away during a single

storm event, highlighting the need to consider extreme weather events in site selection planning. Further, invasive green iguanas were active in the decoy areas and interacted with decoys and mirrors. Green iguana adults are mostly herbivorous, but are reported to occasionally depredate bird eggs, chicks, invertebrates, small mammals and carrion as well (Enge et al., 2007). Green iguanas were first recorded on Desecheo in 2012, and their population already appears well-established. This invasive species may represent a limiting factor for the establishment of successful seabird nesting; however, more information is needed to understand the effects, if any, they may have on ground-nesting seabird species. We recommend prioritizing research to evaluate their impact and considering actions to manage green iguanas on Desecheo.

We demonstrated that bridled terns and Audubon's shearwaters are directly interacting with the social attraction project indicating a positive outcome for two of the three focal species and potential for application to other seabird species on Desecheo and on other islands in the Caribbean. For the Audubon's shearwaters, this is particularly noteworthy given the conservation status of this species in the Caribbean. Given they are less site faithful and can move colony sites from year to year, we expect that bridled terns have a strong capacity to respond to social attraction projects and grow in number on Desecheo. By comparison, we expect the establishment of an Audubon's shearwaters breeding colony to be slower, given there is no record of them from the island, and breeding adults are typically more site faithful, leaving younger prospecting birds as the primary demographic likely to respond to any social attraction stimuli. While brown noddies did not appear to interact with social attraction equipment, we expect this can be overcome through additional time and possible placement at alternative sites. Our results provide optimistic early indicators that social attraction and monitoring methods should be continued to augment populations of bridled terns and brown noddies and establish Audubon's shearwater at Desecheo Island. Should resources become available, testing call-playback and decoys in different habitat types would improve understanding of attractant efficacy and inform future deployments. Investigating methods of social attraction for larger species such as the brown booby are also important next steps given their significant historic numbers on the island. As both a historically important seabird rookery and a potential refuge from projected sea level-rise impacts, Desecheo's restoration as a seabird breeding colony remains an important conservation goal for the Caribbean.

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AUTHOR CONTRIBUTIONS

NH and SS conceived of the project ideas. NH and JLH designed methodology. RC, JLH, CF, EV and CW collected and curated the data. JLH, CF and CW analyzed the data. All authors contributed to writing, editing and reviewing the manuscript and gave final approval for publication.

DATA AVAILABILITY STATEMENT

All data are available through the Dryad Digital Repository: <https://doi.org/10.5061/dryad.h9w0vt4hb> (Herrera-Giraldo et al., 2021).

PEER REVIEW

The peer review history for this article is available at <https://publons.com/publon/10.1002/2688-8319.12058>.

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