Important foraging areas of seabirds from Anguilla, Caribbean: Implications for marine spatial planning

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ARTICLE INFO

ABSTRACT

Marine spatial planning (MSP) has become an important tool to balance the needs of commercial, economical and recreational users of the marine environment with the protection of marine biodiversity. BirdLife International advocate the designation of marine Important Bird Areas (IBAs) as a key tool to improve the protection and sustainable management of the oceans, including the designation of Marine Protected Areas, which can feed into MSP processes. This study presents the results of three years of seabird tracking from the UK Overseas Territory of Anguilla, where marine resources are currently relatively unexploited and MSP is in its infancy. The core foraging areas of 1326 foraging trips from 238 individuals, representing five species (brown booby *Sula leucogaster*, masked booby *Sula dactylatra*, sooty tern *Onychoprion fuscatus*, magnificent frigatebird *Fregata magnificens* and red-billed tropicbird *Phaethon aethereus*) breeding on three of Anguilla's offshore cays were used to calculate the hotspot foraging areas for each study species. These high activity areas were then compared with fishing activity within Anguilla's Exclusive Economic zone and to proposed coastal developments. Two marine IBAs were identified within Anguilla's waters: the first to be defined, using seabird tracking data, in the Caribbean region. Whilst the level of fishing activity and associated seabird by-catch is hard to quantify, the core foraging areas of seabirds breeding in Anguilla were observed to overlap with areas known for high fishing activity. These findings highlight the need to work both nationally and across territorial boundaries to implement appropriate marine spatial planning.

1. Introduction

The marine environment supports a range of activities such as mineral extraction, shipping and energy production, large and small-scale fisheries and aquaculture as well as providing many people with recreational opportunities [1,2]. Marine ecosystems also represent a vast biodiversity resource and their commercial exploration raises the concern of conservationists, who have been working in close collaboration with the relevant authorities to designate Marine Protected Areas (MPAs). Marine Spatial Planning (MSP) is a mechanism that brings together multiple users to make informed and coordinated decisions on how to use marine resources in a sustainable way [3,4] and is used to reduce conflict between stakeholders. Areas where fishing and/or recreational activities are limited or excluded, such as within MPAs, have proven to be effective tools within the MSP process for the conservation management of marine species and the promotion of sustainable livelihoods [5–7].

It is, however, often a challenge to predict and define what activities should be allowed or restricted in any particular marine area. A further difficulty in the designation of marine protected areas is that much of the biodiversity that uses the marine environment is inconspicuous to humans, often requiring expensive high-tech equipment to monitor [8,9]. In addition, marine species that demand protection tend to also be highly migratory [10]. The use of seabirds to inform marine spatial planning has been tried and tested [11] with both at-sea survey data [12] and tracking data being used to map areas of high seabird species richness [13,14]. Such areas, in turn, are likely to represent key marine habitats or

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important sites where fish congregate [15]. These results have then led to recommendations in the designation of marine protected areas and in the demarcation of marine area zones [12,16,17].

Several approaches exist to predict seabird distribution around colonies from the sea-ward extension approach which defines a mean and a maximum foraging radii around a colony based upon previously recorded foraging radii of the species or closely related species [18]. Predictive modelling has also been implemented around colonies using habitat and bathymetry preferences of seabird species. If enough information is known about the foraging ecology of a species this approach can predict foraging hotspots in the absence of any tracking or at sea survey data [19]. The application, however, of actual at-sea movement through boat/aerial based transects around the colony [20] or collection of tracking data provides more accurate and reflective data to allow marine Important Bird Area (IBA) designation. A range of methods have been implemented to allow researchers to use tracking data to identify important foraging areas for central place foragers, from kernel density methods [21] to time in grid approaches [22,23].

Birdlife International has recognised that, in the face of a proliferation of analytical and modelling approaches, there are advantages in having a standardised approach to designating important at-sea areas for seabirds. Since 2004, the Birdlife Global Marine Programme has designated these areas in the form of marine IBAs. Marine IBAs sit alongside terrestrial IBAs, which Birdlife International has been advocating since 1981. Terrestrial IBAs support important breeding populations, range restricted species, or congregations of migrating/wintering birds. The IBA designation helps to set priorities and focuses action for conservation. To date, BirdLife International has identified over 12,000 terrestrial IBAs globally, of which 1600 have been identified due to their important breeding seabird populations. Seabirds, however, spend the majority of their time at sea and most rely entirely on marine resources for prey, thus whilst terrestrial IBA designation may help protect breeding sites, the important foraging grounds of colonies are often overlooked. The new marine IBA designation is an effort to combat this problem. It is anticipated that these marine IBAs will make a vital contribution to initiatives aimed at improved protection and sustainable management of the oceans, including the designation of MPAs [24]. The optimal approach for designation is through the use of colony-specific empirical data from seabird tracking and a repeatable analytical framework has recently been described [25].

The UK Overseas Territory of Anguilla is located in the northwest region of the Caribbean's Lesser Antillean chain of islands (Fig. 1). Whilst mainland Anguilla lacks any large breeding seabird colonies its offshore cays excel in this area [26,27], with four out of its seven cays designated as terrestrial IBAs due to their important seabird populations [28], and one, Dog Island, representing the most important site for seabirds in the Lesser Antilles (based on number of globally important populations and breeding numbers) [26,29]. Five seabird populations breeding in Anguilla have also been designated as globally important and 12 as regionally important due to their breeding numbers representing > 1% of the global or regional population, respectively [28].

The threats facing Anguilla's seabird populations range from negative interactions with fisheries to coastal development. Anguilla has a relatively small artisanal fishing fleet contributing 1.8% to Anguilla's GDP in 2010, composed of approximately 105 vessels with the majority being open vessels (canoe-like) ranging from 4 to 15 m in length, with 87% being 5–11 m vessels. This industry directly employs approximately 234–300 fishers, with 60% of these reporting to be part-time fishers [30]. In 2015, it was estimated that 59 vessels were using fishing methods that have previously been reported to be a cause of seabird by-catch, including use of hand lines, trolling, and vertical long-lining (Table 1) [31,32] There
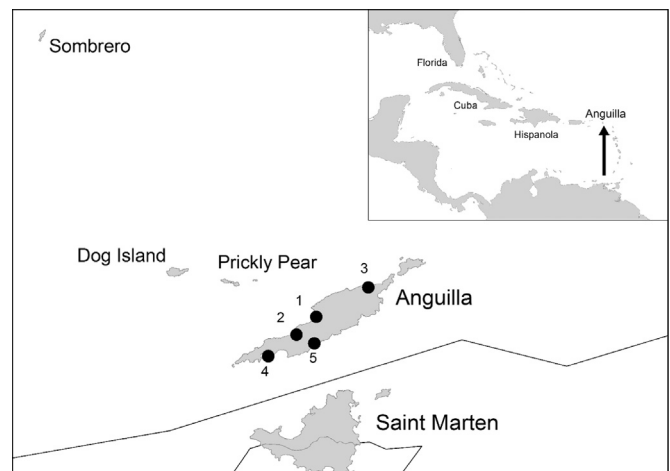

Fig. 1. Map of Anguilla mainland and offshore cays and location of fishing villages (black circles). Insert map showing location of Anguilla.

Table 1
Estimated number of fishing boats in Anguilla using fishing methods that have previously reported seabird by-catch. (Fishing village locations can be seen in Fig. 1) (Data [30]).

Fishing method	Estimated number of boats/fishing ports					
	Cove Bay (1)	Sandy Ground (2)	Island Harbour (3)	Crocus Bay (4)	Blowing Point (5)	Totals
Trolling	0	4	10	0	1	15
Handlines	4	6	15	4	8	37
Vertical longlines	0	2	5	0	0	7

is also an increasing number of charter operators in Anguilla offering angling trips for tourists. Sports-fishing is also popular in the nearby British Virgin Islands (140 km from Anguilla) and Sint Maarten/Saint Martin (13 km from Anguilla). *Ad hoc* reports to the Anguilla National Trust from charter angling boats reveal that birds are occasionally caught on hooks and lines and small amounts of fishing line have been recorded in the magnificent frigatebird colony on Dog Island. There is also a Memorandum of Understanding (MOU) currently in place between the Government of Anguilla and private investors allowing for the development of marinas suitable for mega-yachts (yachts longer than 40 m) on the southern coastlines of Anguilla and one project proposal for a further marine development on the north-west coast, thus likely increasing boat traffic to Anguilla and potentially increasing recreational fishing effort and pollution.

This study uses tracking data collected from both globally and regionally important seabird populations breeding on Anguilla's offshore cays to identify important foraging areas within and around the territory. Identified foraging areas were also related to potential threats including fishing activity and potential marina development around Anguilla's coastline. Since both MSP and marine resource exploitation are in their infancy for this territory, Anguilla provides an ideal opportunity to integrate biodiversity requirements into marine plans before catastrophic interactions occur. A new approach for defining marine Important Bird Areas was tested, these methods developed by BirdLife International use freely available R statistical software [25]. The identification of important foraging areas for Anguilla's seabird populations will allow policy makers to make informed decisions on marine protected area designation within Anguilla's Exclusive Economic Zone.