Important Bird Areas
Ascension Island

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Plate 001. Ascension Frigatebird *Fregata aquila* and Sooty Tern *Onychoprion fuscatus*.
Credit: Derren Fox

Abstract Ascension Island is a UK Overseas Territory in the tropical South Atlantic that supports regionally and globally important nesting populations of 11 seabird species. Its status as one of the most important warm-water seabird breeding stations in the world is probably linked to its isolated position close to a zone of elevated productivity driven by equatorial upwelling. Prior to human settlement in 1815, it is believed that Ascension was home to millions of seabirds but the introduction of cats *Felis catus* resulted in rapid population collapse and the displacement of all but one of the ground-nesting species from the mainland. Breeding seabirds became confined to inaccessible cliff ledges and 14 small offshore stacks. A Seabird Restoration Programme began in 2001 and since the eradication of feral cats, seabirds have resumed nesting on the mainland in significant, and still-increasing, numbers. The Island has three Important Bird Areas. Yet challenges remain: on land, careful management of invasive plants and rodents; at sea, sustainable management of regional fish stocks. The recent establishment of one of the world's largest marine protected areas is a major landmark for nature conservation on Ascension and will set the backdrop for future research on the island's seabirds.

Introduction

Ascension Island (7º 57' S, 14º 22' W) is located in the heart of the South Atlantic, 1,660 km from Africa, 2,250 km from South America, and approximately 80 km west of the Mid-

Atlantic Ridge at the junction of the African and South American tectonic plates (fig. 1). The island is roughly triangular in shape and covers an area of 97 km^2, stretching 11.5 km from north to south and 14 km from west to east. Formed approximately one million years ago from the eruptions of an underwater volcano along the mid-Atlantic Ridge, Ascension Island is a land of contrasts: from barren, volcanic landscapes, largely devoid of plant life, around the coast, to the lush, predominantly man-made cloud forest of Green Mountain (plate 002). Over geological time the island has expanded through a series of spectacular eruptions originating from different vents, which, together with the influence of the prevailing southeasterly trade winds and swells, have given rise to a varied topography. Central and eastern parts are generally higher and more rugged, with sheer sea cliffs plunging into the ocean; western and northern areas consist of a low, gently sloping plain fringed by sandy beaches. The youngest eruptions were just over 500 years ago (lava flows near Comfortless Cove and Sisters Peak; Preece *et al.* 2018), and thus it is technically an active volcanic system.

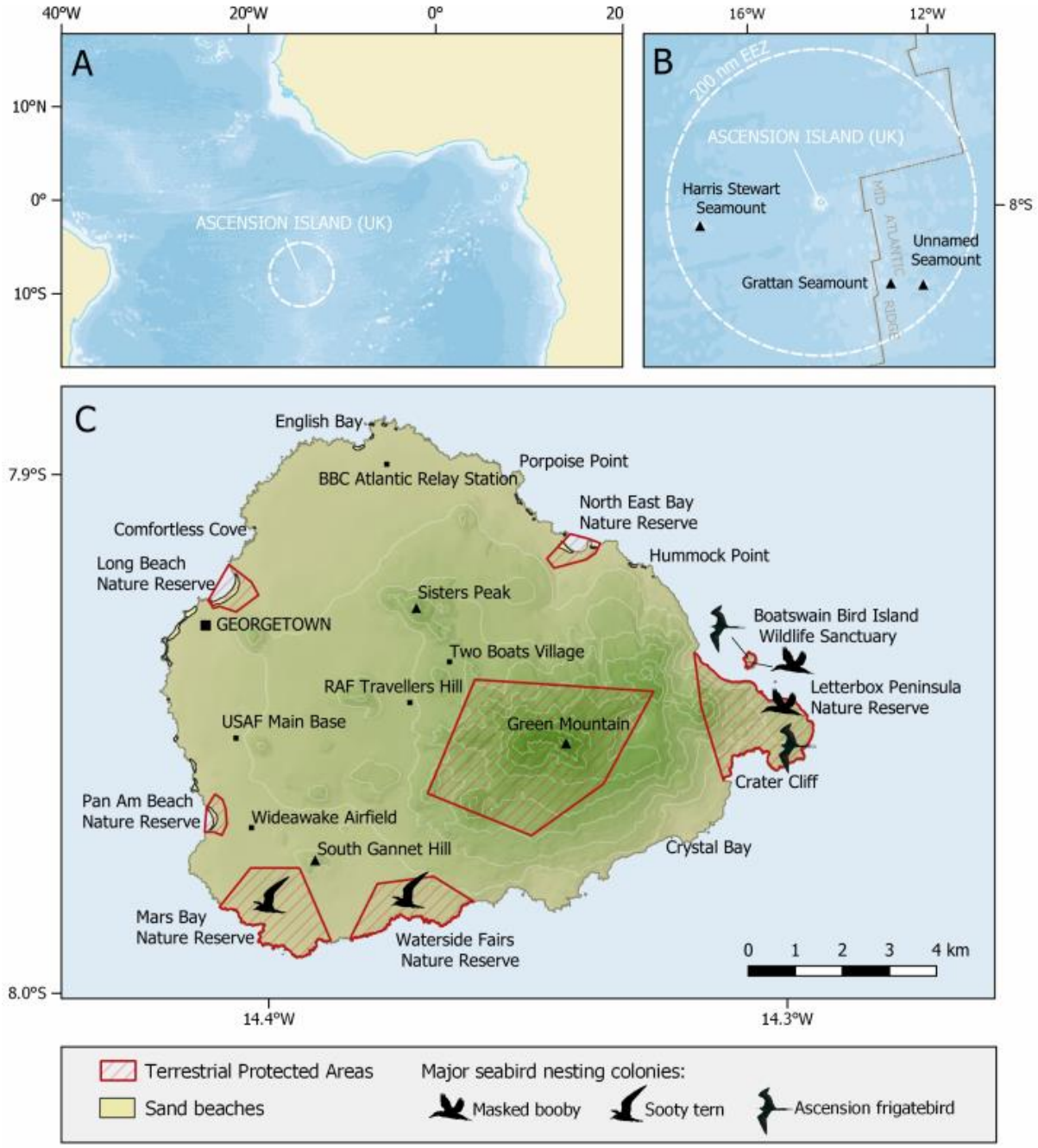

Fig. 1. Ascension Island: its location within the South Atlantic (A); bathymetric features within the 200-nautical mile marine zone (B); and features of interest (C).

Ascension has a dry, tropical climate with no natural running or standing fresh water and limited seasonal variation in temperature and rainfall (Gray *et al*. 2009). In coastal and low-lying areas, the climate is arid, with mean daytime temperatures of 26ºC and annual rainfall < 170 mm (Gray *et al*. 2009). The natural landscape in these areas consist of exposed lava flows and sparsely vegetated plains of loose volcanic scoria and ash, punctuated by dormant cinder cones from past eruptions. Annual rainfall increases to 680 mm at 660 m on the slopes of the highest peak, Green Mountain (859 m), which is frequently shrouded in mists as moisture-laden trade winds are forced to rise over the peak. These regular mists

contribute much of the available moisture at higher altitudes and early visitors to Ascension described a unique montane flora dominated by ferns and mosses.

Ascension is a geologically young island and this, together with its isolation, explains its comparatively species-poor biodiversity. Despite the relative youth of the flora and fauna, the degree of terrestrial and marine endemism is high, with at least 55 endemic species of plants, fish and invertebrates recorded to date. The island also supports the largest Green Turtle *Chelonia mydas* and seabird nesting colonies in the tropical Atlantic. The elevational transition from barren volcanic landscapes to montane mist vegetation represents a rare set of natural habitats. In the past two centuries, however, human exploitation and species introductions have resulted in considerable ecological change.

Plate 002. The varied terrestrial landscapes of Ascension Island (clockwise from top left): volcanic landscapes looking down from Sister's Peak, the site of the most recent volcanic activity; the cliffs of Letterbox Peninsula with views of Boatswain Bird Island; the summit of Green Mountain in the centre of the island; and Long Beach, the island's key Green Turtle *Chelonia mydas* nesting beach. ***Credits: Top left – AIG Conservation Department; Top right – Nicola Weber; Bottom left - Steve Weber; Bottom right – AIG Conservation Department***

For hundreds of years after its initial discovery in 1501, by the Portuguese explorer João da Nova, Ascension Island remained arid and inhospitable. Accounts from passing sailors describe their often futile efforts to find fresh water, although Captain William Dampier described finding water miles inland 'beyond a very high mountain', after his vessel HMS

Roebuck was wrecked on the coast. Charles Darwin visited Ascension briefly, in 1836 during the homeward journey of HMS Beagle, and wrote: 'The Island is entirely destitute of trees, in which, and in every other respect, it is very far inferior to St. Helena' (Darwin 1839). Efforts to secure a reliable supply of fresh water dominate many of the earliest records for the island and, until desalination plants were installed at the BBC's Atlantic Relay Station in the 1970s, it is this that has largely controlled the occupation and development of Ascension since its discovery. Ascension Island has a human population of approximately 800 (2016 census) and, with no right of abode, there is no indigenous population or permanent residents; all land is owned by the UK Government and civilians may reside only as long as they have a work permit. There are two military bases (UK and US), two civilian settlements (Georgetown and Two Boats) and various stations related to telecommunications. The island's main source of income is created through the military and telecommunications presence on the island, supplemented by low levels of international tourism and philatelic sales. Some revenue has also been generated through the sale of commercial fishing licences. The rich cultural history of the island is described in Hart-Davis (2016).

The early 1800s saw the building of a track up the side of Green Mountain and numerous tanks and pipelines between there and the main settlement in Georgetown. Farm and garden plots were started and life became more tolerable for the British Royal Navy, garrisoned on the island as a strategic outpost to guard against French attempts to liberate the emperor Napoleon, who was imprisoned on St Helena, some 1,300 km to the southeast. Under naval occupation, Ascension became an established imperial outpost, and was a rest stop and victualling station for merchant mariners, scientists and explorers plying the trade routes to the Cape and the East Indies. The eminent botanist and director of the Royal Botanical Gardens, Kew, Joseph Hooker visited Ascension in 1843 and at the encouragement of Darwin, left with grand plans for tree and vegetation plantations. With the help of John Lindley, Hooker developed a strategic plan that would irrevocably change the natural character of Ascension. The next 50 years saw mass planting of organised forests, shrub-lands and pastures, introducing over 220 exotic plant species from diverse parts of the world, with the aim of greatly increasing mist interception, soil development and water-storage capacity, and reducing erosion. Hooker's pioneering work lives on to this day: Green Mountain has a man-made cloud forest and a wild botanical garden with trees and plants from around the world growing side-by-side. However, Green Mountain continues to divide opinion. To some it represents a grand experiment in ecological terraforming, in which a new, 'functioning' ecosystem has been created from scratch (Wilkinson 2004). To others it is simply another example of man-made biological invasions, degrading a previously pristine island environment (Gray 2004). The consequences for the island's native flora have certainly been disastrous, with three of the ten known endemic vascular plants now believed to be extinct and six of the remaining seven regarded as Critically Endangered (http://www.iucnredlist.org).


Plate 003. A drawing of Green Mountain in the early 1800s by William Allen a Navy lieutenant passing through Ascension (left) and the abandoned Marine Barracks from the late 1800s in the modern-day, mist-covered Green Mountain. Credits:
Left - Ascension Island Heritage Society; Right – Sam Weber

The Avifauna: seabirds

Ascension supports 11 species of breeding seabirds: the endemic Ascension Frigatebird *Fregata aquila*, the Atlantic's largest population of Sooty Terns *Onychoprion fuscatus*, Band-rumped Storm Petrel *Oceanodroma castro*, White-tailed *Phaethon lepturus* and Red-billed Tropicbird *P. aethereus*, Masked *Sula dactylatra*, Red-footed *S. sula* and Brown Booby *S. leucogaster*, Brown *Anous stolidus*, and Black Noddy *A. minutus* and White Tern *Gygis alba*. The nesting colonies of these species fall primarily within three key areas recognised as Important Bird and Biodiversity Areas (http://www.birdlife.org) and protected under local legislation (the National Protected Areas Order, 2014), which restricts development and regulates other forms of human activity. These are: Boatswain Bird Island, a Wildlife Sanctuary that also has restricted access; the Letterbox Peninsula Nature Reserve; and the Wideawake Fairs Nature Reserve (see fig. 1 & plate 005). The designation of these IBAs in 2014 followed a reclassification from the previous blanket IBA designation for the whole of Ascension (Rowlands 2001). Boatswain Bird Island – a small (5 ha), guano-covered islet, 300 m off the southeast coast – supports nine of the 11 breeding seabirds and for several it is their main breeding colony on Ascension. This includes >90% of the world population of Ascension Frigatebird, along with a unique invertebrate fauna that feeds among the seabird colonies. Letterbox Peninsula, a 337-ha, sheer-sided projection of land at the south-eastern tip of the main island, provides nesting habitat for seven of the 11 species, including the principal mainland colonies of Masked Booby and Ascension Frigatebird. Wideawake Fairs, two flat, low-lying coastal plains (447 ha in total) in the southwest corner of the island, support three breeding seabirds and are best known for their vast colonies of Sooty Terns, Ascension's most numerous seabird. All seabirds on Ascension are protected under the local Wildlife Protection Ordinance, 2013, which prohibits the killing or capture of seabirds or their eggs without licence.

Plate 004. Some of the breeding seabirds of Ascension Island. Clockwise from top left: White-tailed Tropicbird *Phaethon lepturus*; Brown Booby *S. leucogaster*; Band-rumped Storm Petrel *Oceanodroma castro* (photographed on St Helena); and Black Noddy *A. minutus*. ***Credits: top left – Sam Weber; top right Stefan Hunt; bottom left – Sam Weber; bottom right David Higgins***

Plate 005. Clockwise from top left: Masked Boobies *Sula dactylatra* on Letterbox Peninsula; Sooty Terns *Onychoprion fuscatus* at Mars Bay, Wideawake Fairs; Masked Boobies and Ascension Frigatebirds *Fregata aquila* on the summit of Boatswain Bird Island; looking across to Boatswain Bird Island from Letterbox Peninsula. ***Credits: Top left and bottom left and right Nicola Weber; top right AIG Conservation Department***

The Avifauna: landbirds

There are currently four resident landbirds on Ascension, all introduced: Red-necked Spurfowl *Pternistis afer* (introduced 1851), Common Waxbill *Estrilda astrild* (1860), Common Myna *Acridotheres tristis* (1879 and 1880) and Yellow Canary *Crithagra flaviventris* (1890). House Sparrows *Passer domesticus* were introduced in Georgetown from 1985 onwards but are now believed to be extinct. The populations of all four are naturalised and apparently thriving but little is known about their population size, ecology and impact on native species. The Common Myna was brought to Ascension in 1879 (and first bred in 1881) for the purpose of controlling cattle ticks. Cattle are no longer present on the island and the other introduced ungulates (sheep and donkeys) now exist only as feral populations. Mynas have been shown to predate Sooty Tern eggs and have been implicated in high levels of breeding failure in some years (Hughes 2008). Saavedra (2009) estimated the myna population on Ascension as 1,000–1,200 birds and recommended their eradication.

From the fossil record, two species of endemic landbird are known to have occurred, both now extinct: the Ascension Night Heron *Nycticorax olsoni* and the flightless Ascension Crake *Mundia elpenor* (Bourne *et al.* 2003a,b). The bones of both species were discovered >2.5 km from the coast and it has been speculated that, while the heron may have fed along the

shoreline and the rail in the herbage on Green Mountain, they may also have foraged among seabird colonies, like the mynas that replaced them (Bourne *et al.* 2003a,b). For an account of the discovery of these bones and many more fascinating insights into the study of Ascension's earlier natural history, see Ashmole & Ashmole (2000).

The Avifauna: migrants and vagrants

Unsurprisingly, given its remote location, there are no regular migrant birds seen on Ascension, but a small number of non-breeding vagrants are recorded each year. Verified sightings include Cattle Egret *Bubulcus ibis*, Purple Heron *Ardea purpurea*, Corn Crake *Crex crex*, Moorhen *Gallinula chloropus*, Turnstone *Arenaria interpres*, Sanderling *Calidris alba*, Common Swift *Apus apus*, Barn Swallow *Hirundo rustica* and House Martin *Delichon urbicum*. Migrant seabirds, such as Cory's Shearwater *Calonectris diomedea* are also regularly observed offshore but rarely approach land (Hughes *et al.* 2015; AIGCD unpublished data). Verified seabird sightings include Leach's Storm-petrel *Oceanodroma leucorhoa*, Trindade Petrel *Pterodroma arminjoniana*, Pomarine *Stercorarius pomarinus* and Arctic Skuas *S. parasiticus* and Kelp Gull *Larus dominicanus*. Vagrancy on Ascension was summarised by Bourne & Simmons (1998), who also noted the familiar correlation between the number of active birdwatchers on the island and the number of vagrants recorded.

Rats, cats and the Seabird Restoration Project

Ascension remains one of the most important warm-water seabird nesting stations in the Atlantic, but this status must be viewed in the context of long-term population declines of many species, in particular as a result of the introduction of non-native mammalian predators. Black Rats *Rattus rattus* were among the first to reach the island, introduced accidently from the ships of visiting mariners. A precise date is unknown, although several sources have implicated William Dampier's ship, the Roebuck, wrecked in 1701, as a possible invasion route. By the 1720s Black Rats were sufficiently abundant for a marooned Dutch mariner to 'fear for his life' (Ritsema 2010). Few biological records are available from this pre-settlement era and the impacts of rats on Ascension's original seabird community must be largely inferred from contemporary sources. It seems likely that rats would have been a persistent presence among Ascension's mainland seabird colonies and may have decimated populations of smaller, burrow-nesting species (Jones *et al*. 2008) such as the storm petrels now confined to Boatswain Bird Island and inaccessible cliffs. It is also possible that rats contributed to the extinction of Ascension's endemic landbirds and even the extirpation of some members of the original seabird community, such as Audubon's Shearwater *Puffinus lherminieri*, sub-fossil remains of which have been discovered among the island's abandoned 'ghost colonies' (Olson 1977).

Rats do not appear to have had a similarly catastrophic impact on Ascension's larger breeding seabirds, whose impressive mainland colonies were described by visiting naturalists right through into the mid nineteenth century (Stonehouse 1960). However, the subsequent introduction of domestic cats in a bid to control the burgeoning rodent population following human occupation of the Island in 1815 led to the rapid decline of all but one of the remaining seabird species on the mainland. When the BOU Centenary Expedition visited the island in 1957–59, the relatively small relict populations that remained survived only on inaccessible cliff ledges and offshore stacks, including Boatswain Bird Island, with the exception of the vast Sooty Tern colony (Stonehouse 1960).

Plate 006. A cat larder with the remains of Ascension Frigatebirds *Fregata aquila* (left) and Sooty Terns *Onychoprion fuscatus* at Wideawake Fairs killed by feral cats. ***Credit: Philip and Myrtle Ashmole (in Ashmole & Ashmole 2000)***

In 2001, a seabird restoration project was initiated by the RSPB and funded by the UK Foreign and Commonwealth Office, with the aim of eradicating feral cats from Ascension and reinstating seabird breeding colonies to the mainland (Ratcliffe *et al*. 2010). At the time, the removal of cats from a comparatively large and populated island represented a considerable challenge, further complicated by the need simultaneously to enact new legislation and import regulations to prevent the island's remaining domestic cats from founding a new feral population. Through the collaborative efforts of many, the last known feral cat was removed from the mainland in March 2004 and the island was declared free of feral cats in 2006. During the project, 38% of domestic cats were killed accidently, which caused public consternation that still persists today among some of those affected (Ratcliffe *et al.* 2010 made recommendations for reducing such problems in future eradications). The recolonisation by seabirds of accessible mainland sites was first recorded in May 2002 and numbers have increased steadily since. The first species to recolonise were tropicbirds, Masked and Brown Boobies and Brown Noddy, followed by Ascension Frigatebird ten years later. Currently, overall numbers are believed to be several magnitudes lower than before human habitation of the island. If there are no major changes in marine productivity, and with on-going efforts to control rat numbers, it is anticipated that seabird numbers will

remain stable or increase in coming years. Fewer than 30 neutered domestic cats remain on the island, all of which are required to be microchipped and registered with the Ascension Island Government (AIG).

In addition to achieving its main objective, the Seabird Restoration Project led to the formal initiation of consistent scientific monitoring and conservation efforts on Ascension through the establishment of the AIG Conservation Department (AIGCD) in 2001 (expanded to the AIG Conservation and Fisheries Department in 2015). In the same year, AIG and the UK Government also signed up to an Environment Charter for Ascension with the aim of conserving its natural heritage. Over the past two decades, the Conservation Department has established a strong presence on the island, growing from one contracted member of staff to ten, plus additional project staff, interns, school graduate trainees, and volunteers in 2019. However, seabird monitoring and habitat management continues to form an important part of the Department's core function, guided by objectives in the Island's National Biodiversity Action Plan (AIG 2015).

In the remainder of this paper, we focus on three of Ascension's better-studied seabird species with regionally or globally important breeding populations: Ascension Frigatebird, Masked Booby and Sooty Tern. The status of these species may be a general indicator for populations of other seabirds using the island and for which some key facts are shown in table 1.

Table 1. Ascension Island's seabird species. Population estimates are from Ratcliffe *et al*. (2010) except Sooty Terns from Hughes *et al*. (2008). The proportion of the global population is from BirdLife (2018) and Atlantic populations are given where known.

	IUCN Status (2019)	**no. breeding pairs**	**% global population**	**% Atlantic population**	**Best places to see on Ascension**
Ascension Frigatebird *Fregata aquila*	VU	6,250	100	100	Frigatebirds can be seen flying above most of the coastal areas of the island; they are often present at Long Beach during the turtle nesting season or in larger numbers toward Hummock Point, commuting to and from Boatswainbird Island and the Letterbox Peninsula.
Masked Booby *Sula dactylatra*	LC	4,500	?	>10	Letterbox Peninsula; Brown and Masked Boobies are also relatively commonly seen flying off English Bay. Masked Boobies nest mainly on the plateaus of Boatswainbird and Letterbox while Brown Boobies prefer clifftops and coastal rocks. Red-footed Boobies nest in small numbers on the numerous stacks and inaccessible cliffs. Most foraging is offshore, but Brown Boobies in particular may be observed feeding around the coast when schools of bait fish are close to shore.
Brown Booby *Sula leucogaster*	LC	1,000	1	–	
Red-footed Booby *Sula sula*	LC	20	0.004	10	

Sooty Tern *Onchyprion fuscata*	LC	350,00-394,000	3.7	–	The Wideawake Fairs – the most accessible is Mars Bay – during the breeding season.
White Tern *Gygis alba*	LC	5,300	1–7	–	Green Mountain or Razor's Edge and Letterbox. Often roost and nest in introduced eucalyptus trees and on inland cliffs visible from the Green Mountain road.
Black Noddy *Anous minutus*	LC	10,100	1.7	–	Brown Noddies can sometimes be seen nesting at the Wideawake Fairs but are most numerous on offshore stacks and the adjacent coastline or on Letterbox Peninsula. Black Noddies can be observed at Pillar Bay or around Letterbox.
Brown Noddy *Anous stolidus*	LC	470	0.08–0.50	–	
White-tailed Tropicbird *Phaethon lepturus*	LC	1,100	2	33	Northwest coast, Letterbox and Boatswainbird Island. Most commonly seen in flight; these hole-nesting species are often easily overlooked once inside their nest crevice.
Red-billed Tropicbird *Phaethon aethereus*	LC	500	2.5–10	17	
Band-rumped Storm Petrel *Oceanodroma sp.*		1,500	–	–	Rarely seen on land during the day, returning to their nesting burrows on Boatswainbird Island at night. Can often be seen feeding offshore during the day.

Species profiles

Ascension Frigatebird

The only seabird endemic to Ascension and its surrounding waters, the Ascension Frigatebird is a large, pelagic, ground-nesting seabird with predominantly dark plumage, slender wings and a wingspan up to 2 m. Adult males are easily recognisable by the conspicuous red gular sacs that are inflated during courtship and juveniles can be identified by their white heads (see plate 007). Unlike other frigatebirds, Ascension Frigatebirds appear to be year-round central-place foragers and have not been found to embark on extensive post-breeding migrations or roost on islands different from their breeding colony (Oppel *et al*. 2017). This may be linked to Ascension's extreme isolation, coupled with a requirement to return to land periodically for moult and sleep (Oppel *et al*. 2017; Weimerskirch *et al*. 2017). Their closest relative is the Magnificent Frigatebird *F. magnificens*, which breeds along the tropical Atlantic and Pacific coasts of North and South America. The comparatively limited dispersal of adult Ascension Frigatebirds does not appear to overlap with the range of any other frigatebirds, which may have contributed to genetic isolation and subsequent speciation (Dearborn *et al.* 2003). Juveniles are more wide-ranging, however, with vagrants appearing occasionally along the coast of West Africa, Brazil, and (most remarkably) twice to the west coast of Scotland (Ashmole *et al*. 1994; Wallbridge *et al*. 2003; Hudson et al. 2014; Williams *et al*. 2017).

Plate 007. Ascension Frigatebirds *Fregata aquila*: male with inflated gulat, juvenile in flight and female with chick. ***Credits: Left and top right Sam Weber; bottom right Nicola Weber***

Ascension Frigatebirds forage over much of the territory's 200-nautical mile maritime zone and beyond into international waters (Oppel *et al*. 2017; fig. 2). Their diet appears to be more conservative than other Ascension seabirds, consisting almost entirely of flying fish of the genera *Exocoetus*, *Cypsilurus* and *Hirundichthyes*. At certain times, small groups can also be observed feeding on Green Turtle hatchlings and Sooty Tern chicks over land. Kleptoparasitism of other seabirds is known, perhaps mainly among juveniles, but is not thought to form a significant part of the species' diet in adulthood (Stonehouse 1962; Stonehouse & Stonehouse 1963; AIGCD unpublished data). Adult frigatebirds have been found to forage in all directions from the island, with trips lasting 1–18 days and covering a total travel distance from 50 km to more than 7,000 km, with significant variation by season and breeding stage (Oppel *et al*. 2017). The same study found that tagged birds exhibit low individual consistency in foraging behaviour, with an unpredictable at-sea distribution.

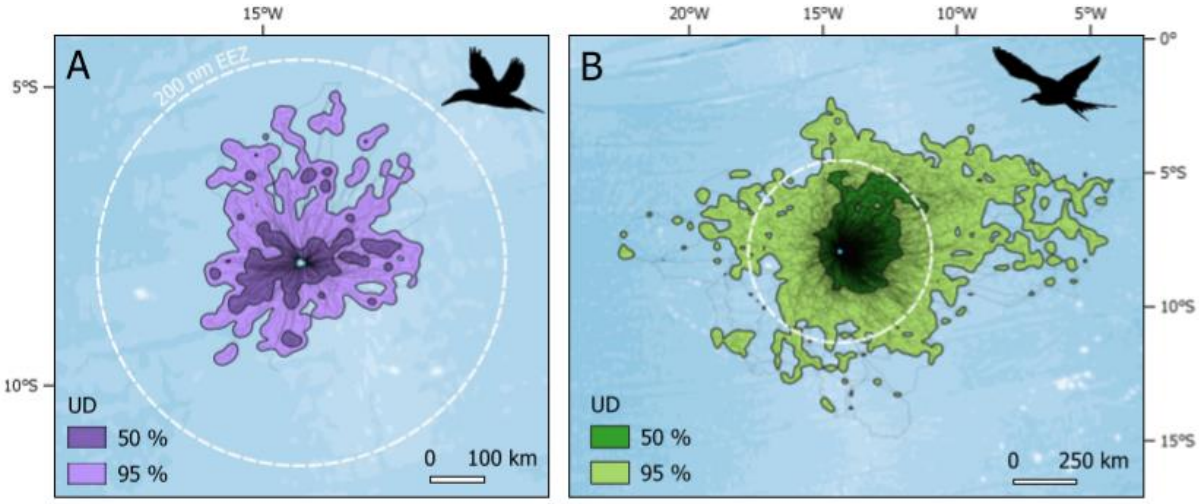

Fig. 2. Utilisation distributions (UD) of foraging A) Masked Boobies *Sula dactylatra* and B) Ascension Frigatebirds *Fregata aquila* tracked using telemetry devices during 2014–16 (adapted from Oppel *et al.* 2015, 2017). Shaded polygons represent the smallest area in which the tracked population had a given probability of being located.

Ascension Frigatebirds nest on bare ground, apparently favouring gentle, windward-facing slopes with rocks for perching. A large proportion (> 90%) currently nest on the summit plateau of Boatswain Bird Island, which for over a century prior to the eradication of feral cats was their sole breeding colony (Stonehouse & Stonehouse 1963). Historical records and subfossil remains suggest that the species once bred extensively across the lowland plains of the main island, with putative colonies located between English Bay and Porpoise Point in the north, close to South Gannet Hill and Crystal Bay in the south, and around Crater Cliff and the Letterbox Peninsula in the southeast (Stonehouse 1962; Ashmole 1963b; Olson 1977; Bourne *et al*. 2003b). In 2012, two pairs were found nesting on the main island after an absence of more than 130 years – a landmark in Ascension's conservation efforts – and this increased to 418 confirmed nesting attempts in the 2016/17 season (Leat *et al.* in prep.). The colony is on the southern side of Letterbox, close to the Devil's inkpot site where the largest concentrations of sub-fossil remains were discovered (Olson 1977).

Prior to the removal of feral cats, competition for nesting space on Boatswain Bird was believed to limit population size (Ratcliffe *et al*. 2008), with nest usurpation and intraspecific aggression being a major source of breeding failure (Stonehouse & Stonehouse 1963). Given the long period before they first breed (probably around 8–10 years), the recent recolonisation of the mainland has presumably been driven by redistribution of existing breeders rather than by absolute population growth. However, the reclamation of former mainland nesting areas may signal the onset of a phase of rapid population growth. Interestingly, recent observations show that a number of mainland breeders have mottled underwings, suggesting that they are young adults and potentially first-time breeders (Leat *et al.* in prep.). Population monitoring away from Boatswain Bird Island is likely to provide valuable insights into the recovery of the population over the coming years.

The inaccessibility of the Boatswain Bird Island colony makes accurate population counts challenging. Only two 'complete' censuses have been conducted, in 1958 and 2001/02. The population was apparently stable over this period with c. 6,250 breeding pairs and a total

adult population of c. 18,600 individuals (Ratcliffe *et al*. 2008). This is surely a substantial reduction compared with earlier times. Records from 1750–80 describe large breeding colonies on the main island, which began to decline rapidly after the introduction of cats in around 1815 and were deserted by the 1880s (Stonehouse 1962).

As for many tropical seabirds, some Ascension Frigatebird nesting occurs year-round, but there is a pronounced peak in egg-laying between September and November and a lull between February and May. A single egg is laid and is incubated by both parents for 43–50 days. Chicks fledge at 6–7 months, but remain dependent for a further 3–4 months post-fledging (Stonehouse & Stonehouse 1963; Ratcliffe *et al*. 2008; AIGCD unpublished data). Data from remote camera-traps has shown no difference in attendance and provisioning rates between male and female parents (AIGCD/University of Exeter, unpublished). This is in line with the equal parental effort displayed by Christmas *F. andrewsi,* Great *F. minor* and Lesser Frigatebirds *F. ariel*, but not Magnificent, where parental duty is shared until the chick is three months, and then it is attended to solely by the female (Trivelpiece & Ferraris 1987). Ascension Frigatebirds undertake post-fledging provisioning (this is common in frigatebirds generally) and the long period of parental care means that successful birds breed only biennially. Nesting success is typically low, however (20–35%) and re-nesting following failure is common (Ratcliffe *et al.* 2008; AIGCD unpublished data). Age at maturity and maximum lifespan are unknown, but based on related species are likely to be in the order of 8–10 years and 40–50 years, respectively (Valle *et al*. 2006).

Sooty Tern

The Sooty Tern – known locally as the 'wideawake' because of the distinctively loud call – is the most numerous seabird breeding on Ascension and in the tropical oceans more generally, with an estimated global population of 35 million individuals. The species nests colonially on isolated, oceanic islands, and the colony of c. 200,000 pairs on Ascension is the largest in the Atlantic (Hughes *et al*. 2012). Sooty Terns often nest in mixed colonies with related species and this has also been noted with Brown Noddies on Ascension.

The Ascension population is morphologically distinct, with larger body mass, wing length and bill length, and is demographically isolated from other Atlantic populations, with little migration between neighbouring colonies (Hughes *et al*. 2010). However, no genetic differences have been found between birds at colonies in the Caribbean and on Ascension, suggesting at least some recent connectivity (Avise *et al*. 2000). The Atlantic and Caribbean subspecies (nominate *fuscata*) is estimated at 1.6–2.1 million individuals (Wetlands International 2015), and is classed as Least Concern by the IUCN, but based on significant declines in the Ascension population and elsewhere, Hughes (2014) argued that reclassification is necessary. The Ascension population has remained apparently stable over the past 20 years, with an average of c. 350,000 birds breeding each year (Hughes *et al.* 2012), but this is likely to represent a substantial decline relative to historical abundance. Using a range of secondary data, Hughes (2014) estimated that the breeding population numbered approximately 2.8–3.0 million birds between 1877 and 1958 but declined precipitously between 1970 and 1990 to its present level.

Sooty Terns on Ascension nest on bare ground or among low, sparse vegetation across an extensive area of flat, rubble-strewn, coastal plain in the southwest corner of the island,

known locally as the 'Wideawake Fairs'. There are two main subcolonies, one at Mars Bay one at Waterside Fairs, although the exact location varies seasonally (Hughes *et al*. 2012). Historically, Sooty Terns nested over a wider area, including major sub-colonies inland of South Gannet Hill, which were displaced during airfield developments in the 1940s (Chapin 1954). A small colony on Boatswain Bird Island disappeared sometime between 1958 and 1990 (Ashmole 1963a; Hughes 2014).

Ascension's Sooty Terns have historically bred on a subannual cycle, returning to the island en masse approximately every 9.6 months (Chapin 1954; Reynolds et al. 2014). In recent years, however, this synchronicity appears to have dampened with birds nesting at the Fairs for a larger proportion of the year in smaller numbers but with a pronounced peak every 9.6 months (AIGCD, unpublished data). This may be a response to the relaxation of predation pressures following the removal of feral cats or the consequence of a series of consecutive years of low breeding success and subsequent renesting. The single egg is incubated by both parents for c. 30 days, and chicks fledge at 8–10 weeks (Ashmole 1963a). The majority return to breed for the first time at 8–9 years old (Hughes *et al*. 2008; Feare & Doherty 2011) and may live for more than 30 years (Army Ornithological Society, unpublished data). Mass breeding failure occurs periodically and circumstantial evidence suggests that at least some of these are related to food shortages resulting from large-scale climatic or oceanographic variability such as ENSO (El Niño Southern Oscillation; Bourne & Simmons 2001, Hughes & Bray 2004).

Sooty Terns are highly pelagic and generally found close to land only during the breeding period. Initial results from tracking work suggest that during the breeding season Sooty Terns forage mainly within Ascension's 200-nautical mile maritime zone, in all directions from the island. Between breeding seasons, the terns appear to forage predominately well to the north, exploiting the productive upwellings of the equatorial Atlantic (University of Birmingham/Army Ornithological Society, unpublished). Their diet is mainly small pelagic fish and squid, caught at or near the ocean surface (Ashmole 1963a); they rely heavily upon prey driven within reach by surface-schooling predators such as Skipjack *Katsuwonus pelamis*, Yellowfin Tuna *Thunnus albacares* and Dorado *Coryphaena* spp. and are seldom seen feeding independently of them in oceanic waters (Au & Pitman 1986; AIGCD unpublished data). A decrease in prey availability linked to the rapid expansion in commercial long-lining for tuna in the tropical Atlantic over the past 50 years, along with climate warming, has been implicated as the principle driver in the apparent collapse of the tern population between the 1960s and 1990s (Hughes *et al*. 2014). Indeed, recent work has shown that a significant dietary shift from a fish-dominated diet to an increasingly squid-dominated diet occurred during the second half of the twentieth century, coinciding with this decline (Reynolds *et al.* 2019).

Plate 008. Sooty Tern *Onychoprion fuscatus*, April 2012. ***Credit: Sam Weber***

Masked Booby

The Masked Booby population on Ascension is depleted but recovering. The mainland colonies were extirpated by feral cats sometime between 1840 and 1880 and, despite several failed recolonisation attempts, breeders remained confined to Boatswain Bird Island until 2002 when the feral cat eradication was initiated (Dorward 1962; Stonehouse 1962; Ratcliffe *et al*. 2010). Masked Boobies were among the first species to reclaim the mainland, with successful nests reported within months of the start of the programme. Breeders are currently concentrated on the summit plateau of Boatswain Bird Island and around Letterbox Peninsula but small numbers can also be found in the vicinity of Cocoanut Bay and Hummock Point. As with the Ascension Frigatebird, the inaccessibility of the main colony makes assessment of population size and trends challenging. Dorward (1962) estimated 1,300 pairs in 1958 with a total adult population of 5,000–8,000 birds; Ratcliffe *et al*. (2010) estimated a peak of 4,500 pairs in 2002. Recent population trends may be more readily inferred from the rapid recovery of the mainland colonies since the start of the feral cat eradication, increasing from three nests in 2002 to a minimum of 1,537 in 2015 (AIGCD, unpublished data). Notwithstanding some redistribution from Boatswain Bird to the mainland, the total adult population is likely to number over 6,000 pairs but is still assumed to be considerably smaller than it once was. Historical records and sub-fossil remains indicate that the species once bred more widely across the coastal lowlands, with putative nesting colonies to the north and east of Sisters Peak and close to South Gannet Hill (Bourne *et al*. 2003b).

Plate 009. Masked Booby *Sula dactylatra* feeding chick, March 2013. ***Credit: Sam Weber***

Masked Boobies nest on open or bare terrain, and while they typically lay two eggs, observations suggest that only a single chick is fledged. Incubation takes about six weeks and chicks fledge at c. 5.5 months, although parents may continue to feed their young at the nest site for a further 3–4 weeks (Dorward 1962). Breeding success on Ascension is comparatively low, at 9–37 % (Ratcliffe et al. 2010). Egg laying is frequently cited as peaking between June and July, but that is based on a single-year study in 1958 (Dorward 1962) and there is clearly substantial variation in breeding phenology; recent monitoring suggests a peak in September–October is more typical in mainland colonies (AIGCD, unpublished).

Masked Boobies are among the most pelagic of the Sulidae, preferring to forage over deep water (Schreiber & Clapp 1987). Those on Ascension have been found to forage widely, although predominantly within the 200-nm maritime zone (Oppel *et al*. 2015; fig. 2). On average, foraging trips of breeders extend up to 140 km from the island with a duration of around 15 hours, although occasional trips of over 300 km from the island have been recorded, with a duration of up to 90 hours. Tracked birds dispersed in all directions from the island, but most frequently to the NNE (21% of trips) and SSE (26%). Most prey is obtained by plunge diving from a height of 10–30 m and, as with Ascension Frigatebird and Sooty Tern, this is often in association with subsurface predators such as dolphins and tuna that drive prey to the surface (Au & Pitman 1988). The Masked Boobies nesting on Ascension are genetically distinct from Caribbean and Indo-Pacific populations indicating limited long-range dispersal (Steeves *et al*. 2015), although one ringed on Ascension was subsequently recorded on St Helena, c. 1,300 km to the southeast (AIGCD unpublished).

Other important flora and fauna on Ascension Island

Terrestrial flora

Around 25 vascular plant species are thought to be native to Ascension, of which seven are known to be endemic (and a further three now believed to be extinct). Two of the seven endemics (*Euphorbia origanoides* and *Asplenium ascensionis*) are considered to be in decline by the IUCN and three (*Anogramma ascensionis*, *Ptisana purpurascens*, *Pteris adscensionis*) are listed as Critically Endangered with unknown population trends (http://www.iucnredlist.org). Ascension's bryophyte flora stands at four hornworts, 23 liverworts and around 50 mosses, with a remarkably high proportion of endemics (two, two and 11 respectively; see Pressel *et al*. 2018). Habitat loss through ecological succession, competition with vigorous invasive weeds, grazing by introduced mammals and non-native pests are currently the main threats facing the endemic flora. The AIGCD and partners are employing a number of methods to preserve the island's botanical heritage. Endemic plants are propagated *ex situ* using a variety of techniques, with the aim of reintroducing these into the wild to establish viable populations. Some specimens are planted out in 'restoration sites' that are fenced to exclude grazers and serve as important refugia for the native flora. Ecological restoration techniques are also being trialled to establish self-sustaining wild populations that are able to co-exist with the Island's predominantly non-native flora. This is not a straightforward task given the scale of ecological transformation that has taken place and often requires a painstaking process of trial and error.

Marine fauna and flora

Ascension's coastal marine environment is characterised by an abundance of fish, a cryptic and largely nocturnal invertebrate fauna and a striking scarcity of erect seaweeds. The island lacks many of the iconic habitats commonly associated with tropical islands, such as coral reefs, seagrass beds and mangroves. Instead, expanses of volcanic rock, rubble and sand predominate. Underwater rock formations consist of bedrock reefs, vertical cliffs and boulder fields, as well as a myriad of caves, canyons and lava tubes. There are also gently shelving areas of coarse sand and maerl cobbles, particularly on the western side of the island. Knowledge of the island's inshore marine biodiversity has advanced rapidly in recent years through a series of collaborative research expeditions (see Brickle *et al*. 2017). A total of 133 'coastal' fish species have been recorded in Ascension waters, which is low compared with other tropical Atlantic islands. However, the community represents a unique assemblage of western, eastern and amphi-Atlantic species and includes 11 single-island endemics and a further 20 species endemic to St Helena, Ascension and St Peter and Paul's rocks (Wirtz *et al*. 2014). It is dominated by the spectacularly abundant Black Triggerfish, *Melichthys niger,* whose relentless grazing severely limits the growth of non-calcareous seaweeds (Stonehouse 1962; Price & John 1977). Instead rocky, sub-tidal areas are dominated floristically by coralline red algae (*Lithothamnia*), or rhodoliths, which provide important habitat for small reef fish and invertebrates. Additional inshore species inventories include 112 benthic algae (Tsiamis *et al*. 2014), 16 species of corals (Opresko 2014; Reimer *et al*. 2014; Zibrowius *et al*. 2014), ten species of heterobranch sea slugs (Padula *et al*. 2014) and 75 species of marine decapods, 11 of which are endemic to Ascension Island (De Grave *et al*. 2014). Six species of cetacean have been recorded from Ascension, including a resident population of bottlenose dolphins *Tursiops* and small groups of Humpback Whales *Megaptera novaeangliae* that visit the Island between September and October in most years, often accompanied by young calves. Many species of large pelagic fish are also drawn to nearshore areas by an abundance of prey and are the targets of a small scale recreational and sports fishery.

Away from the coast the seabed drops away rapidly and waters deeper than 1 km make up more than 99% of the island's 200-nm zone (the Exclusive Economic Zone or EEZ). The epipelagic (surface) fauna in this oceanic zone are largely comprised of highly mobile, cosmopolitan tropical species, such as oceanic sharks, dolphinfish, wahoo and billfish. Tropical two-winged flying fish *Exocoetus volitans* are particularly common in offshore areas and form a major part of the diet of seabirds and other higher predators. Studies of Ascension's deep-sea habitats are still in their infancy, largely as a result of the challenges in data collection. The mid Atlantic ridge runs for approximately 80 km through the southeast quadrant of the EEZ and includes four known hydrothermal vent fields, where hot, mineral-rich waters spew out from fissures in the Earth's crust supporting unique biological communities built around the action of chemosynthetic bacteria (Melchert *et al.* 2008). Three prominent seamounts also lie within the Island's EEZ, including two shallow-water features (<100 m) associated with the mid Atlantic Ridge (Grattan and Young seamounts) and a third deeper feature located approximately 260 km west of Ascension (Harris Stewart Seamount). Ascension's shallow water seamounts have recently been shown to support significantly increased abundance and richness of marine life compared with the surrounding deep ocean and are likely to be given full protection under plans for a large MPA in the territory's waters (Weber *et al*. 2018).

Plate 010. Shallow marine biodiversity at Boatswain Bird Island, Ascension Island, August 2012. ***Shallow Marine Survey Group***

Turtles

Besides its seabirds, Ascension is perhaps best known among naturalists for its globally important nesting population of the Endangered Green Turtle: the second-largest nesting aggregation of in the Atlantic and the largest nesting population of any marine turtle in the UK Overseas Territories (with some 25,000 nests recorded annually; Weber *et al*. 2014). The Ascension population is genetically distinct from others in the Atlantic (Bowen *et al*. 1992)

and migrates more than 2,000 miles from coastal feeding areas distributed along the Brazilian continental shelf to nest on Ascension's sandy beaches between December and June. Turtles were exploited for meat by passing sailors from the island's discovery and this intensified following settlement in 1815, resulting in a severely depleted population (Huxley 1999; Broderick *et al*. 2006). Harvesting had largely ceased by the 1940s and the population has since rebounded strongly (Huxley 1999; Weber *et al*. 2014). Current population estimates are still below pre-exploitation levels; but with good protections in place locally and an improving situation in the Brazilian feeding grounds their status is considered to be favourable.

In addition to Green Turtles, small numbers of the Critically Endangered Hawksbill Turtle *Eretmochelys imbricata* are also found on shallow, rocky reef habitats around the island. All individuals captured to date have been juveniles and it seems likely that the island serves as a mid-Atlantic refuelling station or developmental habitat for maturing individuals on extended oceanic migrations before recruiting to their adult foraging grounds in Brazil or tropical West Africa (Weber *et al*. 2017).

Plate 011. A female Green Turtle *Chelonia mydas* covering up and disguising her nest on Long Beach, Ascension's principle nesting site for this species, March 2008. ***Sam Weber***

Current threats to species/populations

Commercial fishing

Ascension lies within an area of high commercial tuna and swordfish long-lining effort (Huang 2011), which potentially poses both direct and indirect threats to seabirds and other marine megafauna. Licenses to fish commercially in the Ascension Island EEZ have been sold by the St Helena and Ascension Island Governments intermittently from the 1980s onwards, primarily to the Taiwanese, Chinese and Japanese distant water longline fleets. License

uptake peaked in the mid-1990s with over 130 licenses sold in some years, although this has dropped to just 1–2 licenses in recent years amidst a series of temporary closures and reforms to management regimes. Few local observer data exist to assess the direct mortality of marine fauna caused by incidental capture in pelagic longlines in Ascension's waters, although the risk to the island's seabirds appears to be negligible because the species involved target active prey and do not typically pursue fishing vessels in search of discards (Blaber *et al*. 1995; Huang 2011; Yeh *et al*. 2013). The indirect impacts of fishing on marine food webs may be of greatest concern for Ascension's seabirds, many of which rely heavily upon subsurface predators, such as tuna, to drive their prey within reach (Au & Pitman 1988). Declines in tuna abundance linked to overfishing would have a potentially significant impact on seabird survival and breeding success. Although the Atlantic Yellowfin and Skipjack Tuna populations are currently believed to be fished sustainably (ICCAT 2008, 2011), Atlantic stocks of large tuna species have declined by an estimated 50–80% over the past 50 years (Cullis-Suzuki & Pauly 2010) and there is some evidence that this may have affected Ascension's seabirds (Reynolds *et al*. 2019). Seabirds are effectively 'sentinel species' and trends in seabird populations, diet and productivity can serve as valuable indicators of the health of the marine environment and should continue to form an important part of any broad-based system for monitoring Ascension's marine ecosystem.

In August 2019, the Ascension Island Council voted to designate a large-scale marine protected area (MPA) covering 100% of the Territory's EEZ, marking an end to commercial fishing and bringing to a close a four-year process of consultation and evidence gathering. At 445,000 km^2, the Ascension MPA is one of the largest in the world and represents a major landmark in the conservation of the Territory's marine biodiversity. However, the extent to which it will affect the island's seabirds and the pelagic ecosystem on which they depend is currently uncertain. Most of the predatory fish species with which seabirds associate are highly migratory and are managed at a regional or whole-Atlantic level through total allowable catches set by the regional fisheries management organisation (ICCAT), meaning that local abundance in Ascension's waters are likely to remain heavily dependent on trends in regional stocks. Species such as the Ascension Frigatebird and Sooty Tern, which routinely range beyond the Ascension EEZ, will also remain at threat from external pressures. Thus, while the designation of the Ascension Island MPA is hugely significant, it does not lessen the need to establish truly sustainable fisheries management across the wider Atlantic, including enhanced protection of high seas areas beyond national jurisdiction.

Invasive species

The impact of non-native species is perhaps greater on Ascension than any other island on earth, with >90% of plant species having been introduced. Prior to human settlement, the native ecosystems on Ascension were at a relatively early stage of development, making them particularly susceptible to invasion by introduced plants. All habitats have been subject to encroachment by introduced species, and today there is virtually nothing that could be described as truly 'native habitat', with the possible exception of some areas of barren coastal desert and some relict fragments of upland vegetation on exposed, misty slopes. The rapid spread of invasive, drought-tolerant shrubs such as *Prosopis julifora*, *Psidium guajava*, *Nicotiana glauca* and *Casuarina equisetifolia* over much of the island's previously barren coastal lowlands also poses a potential threat to other native species such as seabirds and turtles by encroachment on nesting areas. Several perennial and annual

weeds such as *Waltheria indica*, *Heliotropium curassivicum*, *Chenopodiastrum murale* and wild tomato (*Solanum*) are also increasingly expanding their range into the seabird nesting areas of the Letterbox Peninsula. The AIGCD are working to maintain 'buffer zones' around these important habitats to ensure that they are kept free from invasive vegetation.

Mammalian introductions to the island include goats (eradicated in 1944), sheep, donkeys, cats, rabbits, mice and rats which have all had a negative impact on the native biodiversity to a varying extent. The impact of feral cats has been described already, but Black Rats are still found in all mainland habitats on Ascension, including the important seabird breeding areas of Letterbox Peninsula and Wideawake Fairs, where rat density is among the highest recorded (Dawson 2013). Rats have never reached Boatswain Bird Island, which is separated from the mainland by a deep-water channel). Unfortunately, rat numbers appear to have increased considerably following the eradication of feral cats (Hughes 2014). The 'greening' of formerly barren, semi-desert areas by invasive shrubs with nutritious fruits, seeds and bark may also have contributed to increased rat abundance in low-lying areas by providing shelter and sustenance during the seasonal absence of nesting seabirds and turtles (Dawson 2013). Rodent predation is not generally considered a significant threat to larger seabirds, but eggs and young chicks, particularly of Sooty Terns, which are sometimes left unattended, may potentially be at risk (Hughes 2014; AIG 2015). Rats have been observed predating Green Turtle hatchlings during the peak turtle hatching season (AIGCD/University of Exeter, unpublished data).

Ascension's size, rugged terrain and the tropical climate, combined with a permanent human population, mean that rat eradication is generally not considered viable at the present time, so management continues primarily through the distribution of poison baits around key biodiversity sites. Implementation of a proportionate, risk-based biosecurity system to encompass the different users of the island is currently a priority for AIG, to prevent the entry and establishment of any future unwanted non-native organisms. Invasive 'tramp ants' have been identified as a particular threat and are known to have significantly affected tropical seabird populations elsewhere (O'Connor 2016).

Plate 012. An invasive Mexican thorn, or mesquite, tree (*Prosopis juliflora*) with bark stripped by the rats that find refuge in these expanding areas of vegetation **[Bullock's Pond, 2014]**. ***Credit: Sam Weber***

Climate change

Few data exist with which to evaluate the interactions between climate, oceanography and seabird productivity on Ascension; however, climatic and oceanic phenomena such as ENSO have been shown to have a significant impact on the reproductive and demographic parameters of tropical seabirds elsewhere in the world (Devney *et al*. 2009; Surman *et al*. 2012). Ascension's importance for breeding seabirds is likely to be related to its position within a zone of elevated productivity, driven by the upwelling of cooler, nutrient-rich waters along the equator. Climatic shifts that affect the intensity of upwelling (either positively or negatively) could have significant impacts on food availability for nesting seabirds. Indeed, mass seabird breeding failures occur periodically on Ascension and there is circumstantial evidence to suggest that at least some may be related to ENSO-like events (Bourne & Simmons 2001).

Climate change-induced sea level rise is perhaps of less concern for seabirds nesting on elevated plateaus and cliffs but represents a potentially significant threat to some of the island's biodiversity, notably nesting Green Turtles. The island's sea level is estimated to have risen by 7 cm since 1955 (Woodworth *et al*. 2012) and this trend is projected to accelerate, which may lead to a reduction in the extent of suitable nesting habitat. In addition, rising temperatures on nesting beaches are predicted to become a major threat over the same time period, skewing sex ratios (sea turtles have temperature-dependent sex determination) and reducing the hatching success of eggs (Hawkes *et al.* 2009). The primary sex ratio on Ascension is already estimated to be 75% female (Godley *et al*. 2002) and incubation temperatures on some beaches are close to the upper limits for embryonic

development during much of the nesting season (Weber *et al.* 2012). Rising temperatures may also affect ground-nesting seabirds, exposing unattended eggs and chicks to potentially fatal temperatures, while cliff- and stack-nesting species may be at increasing risk of wave damage if the heavy swells that periodically affect the island increase in frequency or severity.

Other anthropogenic threats

In April 2010, five 53.5-m wind turbines were erected adjacent to the BBC power station complex at English Bay and have since become a small but consistent source of seabird mortality. The turbines sit on an important coastal flyway for birds commuting to and from Boatswain Bird Island (Bourne & Simmons 2001) and kill 30–40 seabirds annually: 50% of these are Ascension Frigatebirds, 40% are Masked Boobies and 10% are others including Brown Booby, Sooty Tern and noddies (AIGCD unpublished data).

Owing to its isolated location, military presence and limited infrastructure, tourist footfall on Ascension has always been limited and is generally perceived as having a negligible environmental impact. Over recent years there have been efforts to develop the island's ecotourism potential further, including targeting those with ornithological interests. In addition, a handful of businesses were established to provide sports fishing charters for an international clientele (with a focus on tuna, wahoo and game fish species such as blue marlin). However, in 2017, the twice-weekly flights between RAF Brize Norton, in Oxfordshire, and Ascension were suspended, pending repairs to the island's runway, and that resulted in the closure of several businesses. Civilian access to the island is currently limited to a monthly commercial flight from South Africa via St Helena, and this means that international tourism remains at a very low level. Runway repairs are currently forecast to be completed in the early 2020s and the tourism strategy will be reviewed in the lead-up to this.

Regardless of the economic future of the island, there is no doubt that, with its spectacular volcanic scenery and globally important marine and terrestrial biodiversity, Ascension will continue to captivate and foster an appreciation of the natural world among those who read about it and are fortunate enough to visit.

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