First recorded breeding attempt of Red-footed Booby *Sula sula* on St Helena Island, South Atlantic

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Abstract

Red-footed Boobies *Sula sula* are a wide ranging species that used to have a significant breeding population on both Ascension and St Helena Island in the South Atlantic. It was thought that only a small remnant population existed at Ascension Island until now. Five breeding attempts on the southern coastal windward side of St Helena by white morph Red-footed Boobies were recorded using an infra-red motion sensitive camera during 2014–2015. Of the minimum of nine eggs laid, none hatched, suggesting more than one female was involved in nesting efforts and they were infertile. The consistent incubation regime and nest attendance observed suggests the parents were experienced breeders. Theories as to where these birds may have come from are discussed.

Introduction

Red-footed Boobies *Sula sula* have a wide range, occurring on tropical islands in most oceans (del Hoyo *et al*. 1992) where they nest predominantly in trees and shrubs. The sub-species, *S. s. sula* is restricted to the Atlantic, predominantly the Caribbean with outposts around the Brazilian Islands of Trinidade and Fernando de Noronha (Harrison 1983), and further east on Ascension Island. The South Atlantic population is approximately 4,000 individuals (den Hartog 1987) and holds both white and white-tailed brown morphs, although the relative proportions of each morph are not known (Nelson 1978). The small, remote islands of Ascension and St Helena, which lie in the South Atlantic Ocean close to the mid-Atlantic Ridge, once harboured significant breeding populations (Ashmole 1963a,b). The introduction of predators following discovery of the islands in the 16th century, and subsequent deforestation of St Helena after human colonisation, reduced the Red-footed Booby populations to a tiny remnant on Boatswain Bird Island, an offshore islet off the southwest coast of Ascension Island (Stonehouse 1962; Simmons 1990). Here we report recent breeding attempts of this species, previously thought to be absent on mainland St Helena, including additional individual observations of non-breeding birds from 2010 to 2015.

Field Observations

Eight individual white morph Red-footed Boobies were opportunistically recorded between 2010 and 2015 (Table 1) on the southern, windward coast of St Helena, with one additional observation on Shore Island, a small rocky offshore islet (Figure 1). This is an area composed of rugged, un-vegetated and heavily eroded ridges, cliffs and stacks. Red-footed Boobies were positively identified by the grey-blue bill and naked skin of the face which had a blush of rose at the base of the lower mandible and on the forehead, just above the dark eyes. The head and neck were also washed creamy yellow and the legs and feet were pink-red in colour. All birds

Table 1. Observations of individual adult white morph Red-footed Boobies *Sula sula* roosting on St Helena Island, 2010–2015 (latitude and longitude Datum WGS 84).

Date	Location		Observer*
26 Oct 2010	Castle Rock Point	(16°1'S 5°44'W)	EC, LH, GS, ELF
2 Nov 2010	Castle Rock Point	(16°1'S 5°44'W)	EC, LH, GS
19 Apr 2011	Above Yellow Sand	(16°0'S 5°44'W)	LH, GS, EC, IH
1 May 2011	Castle Rock Point	(16°1'S 5°44'W)	AB, ET, ST, RB
3 Nov 2011	Shore Island	(15°58'S 5°38'W)	LH, EC
15 Dec 2011	Castle Rock Point	(16°1'S 5°44'W)	LH, AB
16 Mar 2012	Castle Rock Point	(16°1'S 5°44'W)	LH, AB
29 Jan 2014	200 m SE of Lot's Wife	(16°0'S 5°43'W)	LH, AB

* Observers - EC: Elizabeth Clingham, GS: Graham Sim, LH: Leeann Henry, ELF: Emma Fowler, IH: Ivan Henry, AB: Annalea Beard, PL: Phil Lambdon, ET: Edward Thorpe, ST: Sophy Thorpe, RB: Remi Bruneton.

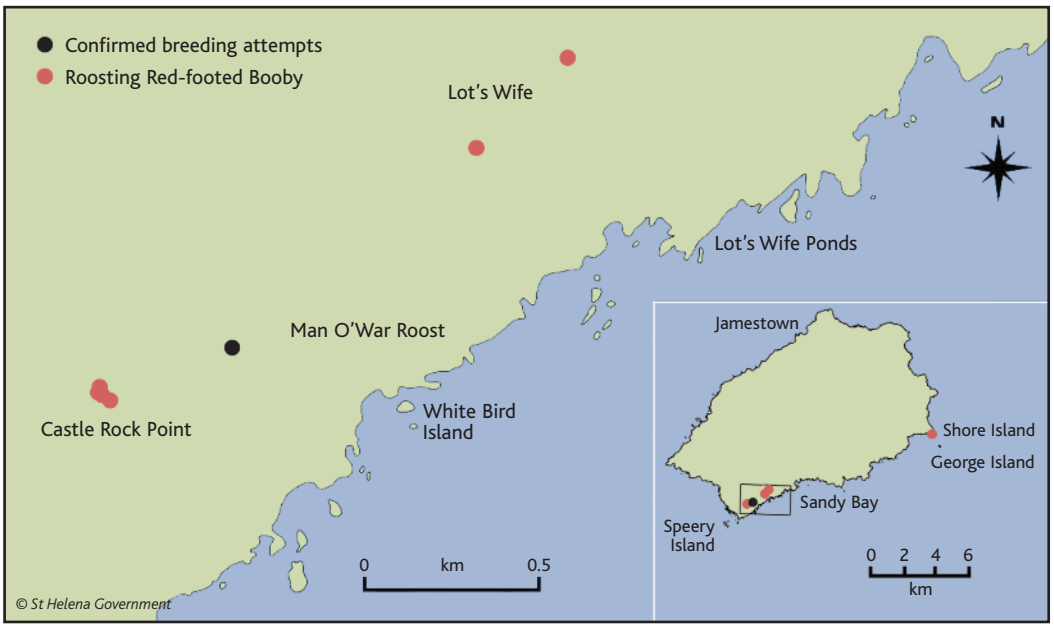


Figure 1. Location of incidental observations of Red-footed Boobies *Sula sula* along the southern coast of St Helena Island, South Atlantic 2010–2015. Lot's Wife, and Man O'War Roost are prominent rock formations that function as visible landmarks.

were observed roosting in areas that were recently re-colonised by Masked Boobies *S. dactylatra* and currently contains an expanding breeding colony with an average breeding success of 47% (Bolton *et al*. 2011; Oppel *et al*. 2015).

Breeding Attempts

On 8 April 2014, two white morph Red-footed Boobies were observed on a steep rocky spur off the sea cliffs near Man O'War Roost, situated on the southwestern tip of St Helena (approx. 16°01'S, 5°44'W; Figure 1). Both birds appeared to be on a territory due to the surrounding rocks being covered in guano and the posture and behaviour of one adult apparently occupying a nest; the bird's body was horizontal with its belly close to the ground and some sticks, which it periodically rearranged during the space of a 20-minute observation period, were visible directly under the bird. This was the first simultaneous sighting of multiple individuals on St Helena.

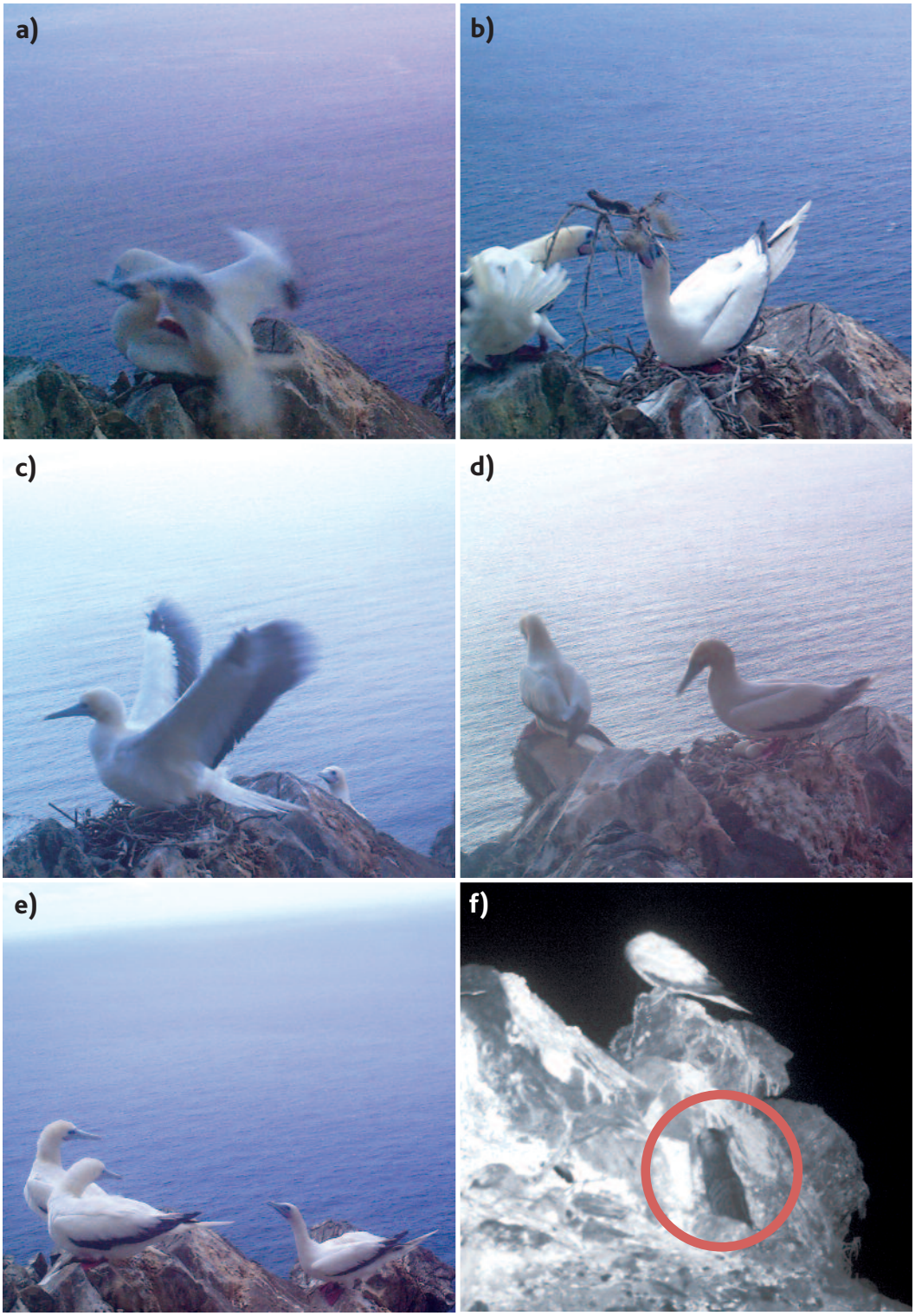
Visual confirmation of an adult incubating an egg was made on 30 April 2014 by visiting the nest site (Table 2). Inspection of the site found four failed eggs within a five-metre radius of the active nest. The eggs were chalky white in colour and had the following dimensions (mean ± SE): length 61.6 ± 2.5 mm, width 38.3 ± 0.3 mm (n = 4). An infra-red motion sensitive camera (Bushnell® Trail camera, set to record continuously at five second intervals) was installed from 7 May 2014 to 7 May 2015 to remotely monitor the area. The camera was positioned to give an ~8 m radius view of the steep rocky terrain around the active nest site. Camera images revealed courtship, mating and nest building behaviour (Figure 2) as well as a further four nesting attempts within a five-metre radius of the first nest (Table 2). These nests were on bare rock with the scrape constructed and lined with small twigs and fragments of stout branches from Lantana *Lantana camara*, Wild Coffee *Chrysanthemoides monilifera* and Melliss's Saltbush *Exomis microphylla var.*

Table 2. Breeding attempts of Red-footed Boobies *Sula sula* recorded on mainland St Helena, 2014–2015.

Breeding attempt	Date clutch recorded *	No. eggs	Date failure confirmed	Fate of eggs
1	30 Apr 2014 (R)	1	15 May 2014	Egg missing
2	31 Jul 2014 (R)	1	28 Aug 2014	Egg rolled from nest
3	08 Oct 2014 (L)	1	28 Jan 2015	Failed to hatch
4	28 Jan 2015 (R)	1	31 Jan 2015	Failed to hatch
5	31 Jan 2015 (L)	2	14 Feb 2015	Egg rolled from nest
			14 Mar 2015	Egg rolled from nest

* R = attempt recorded, date of laying uncertain, L = date of laying confirmed from camera images

Figure 2 (overleaf). The Red-footed Booby *Sula sula* on mainland St Helena Island. Images recorded from an in-situ infra-red motion sensing camera (Bushnell Trail camera model 119437C). a. Two Red-footed Boobies copulating (23 May 2014). b. Two Red-footed Boobies nest building (18 June 2014). c. A Red-footed Booby incubating an egg (31 July 2014). d. A Red-footed Booby incubating two eggs (7 February 2015). e. Three Red-footed Boobies roosting (7 June 2014). f. One roosting Red-footed Booby and a feral cat *Felis catus*. The red circle indicates the location of the cat (23 April 2015).


a)
b)
c)
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axyrioides. The average incubation stint was 25 hours (Table 3). The incubation regime between adults was fairly consistent with change-overs occurring at regular intervals and an adult attending the egg at all times except when the egg was either rolled out or abandoned. Off duty adults would often return to the nest in-between stints carrying nest material or to mate. An adult would also often roost overnight near the nest before leaving in the early hours of the morning. During the monitoring period up to three individual white morph adults were captured on camera together on 17 separate occasions in the area (e.g. Figure 2e). At least two feral cats *Felis catus* were pictured on three separate occasions during which the Red-footed boobies remained at the nest site and/or continued to incubate an egg thereafter (e.g. Figure 2f).

Discussion

The dimensions of the eggs found near the initial nest are consistent with known measurements of Red-footed Booby eggs; they are also larger than the expected size for Masked Booby (Nelson 1978) known to breed in the area (Bolton *et al*. 2011). It is uncertain if more than one pair attempted to nest because individual identification was not possible. However, Red-footed Boobies generally lay one egg and only a small proportion will replace lost or failed eggs (Nelson 1978). Given that up to three adults were recorded together from remote camera monitoring and a minimum of nine eggs were known to have been laid, including one replacement egg, it seems very likely that more than one female was involved in the nesting efforts. Due to the geographical location of the site it was not possible to position the camera to get a full overview of the ridge; this might have enabled confirmation of the total number of Red-footed Boobies in the area.

It is unusual but not surprising that a renowned tree and shrub nesting species (Fisher 1951; Amerson & Emerson 1971) chose a steep rocky outcrop on St Helena to nest in the absence of suitable flora. On Ascension Island, the closest breeding colony to St Helena (1,200 km away), Red-footed Boobies also utilise steep cliffs to nest (Simmons 1990; Ashmole 1963c). The use of locally abundant plant species in the nest scrapes (Lambdon 2012) is also consistent with the behaviour of other breeding Red-footed Booby populations (Nelson 1978).

Only intact eggs were found at the nest site and the images captured from the motion sensor camera of low-level feral cat activity indicate that, thus far, feral cats have not caused the failure of any Red-footed Booby breeding attempts. Masked Boobies re-colonised this area despite the presence of feral cats (Bolton *et al*. 2011), which do not appear to substantially reduce their breeding success (Oppel *et al*. 2015). Although we recorded no predation, none of the Red-footed Booby eggs hatched, suggesting they may have been infertile. Infertile eggs in Red-footed Boobies generally account for low proportions of overall egg loss; for example, 9.3% of eggs were infertile in British Honduras (Verner 1961) and 9.8% were infertile at Tower Island, Galápagos (Nelson 1969). However, low hatching success is considered fairly common especially in the Galápagos due to the special nature of the terrain and high rate of abandonment during periods of food shortage (Nelson 1978).

Table 3. Number and duration (in hr:mm) of incubation stints for five Red-footed Booby *Sula sula* breeding attempts on St Helena. An incubation stint was only recorded where a clear change over occurred between two adults. Note nesting attempt five is assumed to be a replacement clutch after nesting attempt four failed, but individual egg identification was not possible. Some incubation stints may be beyond the expected hatch date, i.e. extra to the normal quota where the laying date was unknown.

Nest	No. of stints	Maximum stint	Minimum stint	Mean ± standard error
1	9	30:51	9:02	18:23 ± 7:08
2	26	42:10	8:46	25:29 ± 9:18
3	28	28:00	10:11	22:32 ± 4:39
4	2	26:17	13:28	19:44 ± 9:07
5	33	58:01	10:53	28:39 ± 10:05

The consistent incubation regime and nest attendance observed suggests that the parents were experienced breeders. The length of the average incubation shift of St Helena's nesting Red-footed Boobies was much shorter than those in the Galápagos (56.8 h), Christmas Island (53 h; Nelson 1969) and Aldabra (37 hours; Diamond 1971) but more in line with the findings from British Honduras where incubation stints averaged 24 h (Verner 1961). Assuming adults are foraging when not incubating, this indicates that the foraging range for Red-footed Boobies on St Helena is probably smaller than on other islands such as the Galápagos where they are forced to go further afield. The shorter foraging range may be a consequence of the relatively small seabird population on St Helena compared to Christmas Island (> 15,000 pairs of three booby species) or Aldabra (6,000–7,000 pairs), with less competition for food resources (Ashmole 1963b; Oppel *et al*. 2015).

Seabird nest monitoring of the windward side of St Helena, particularly around Sandy Bay, has increased since 2009 due to the re-colonisation of the mainland by Masked Boobies from offshore islets (Bolton *et al*. 2011). This may have enabled detection of a re-colonisation or an unknown relict population of Red-footed Boobies on St Helena. These Red-footed Boobies may simply be immature birds emigrating from Ascension Island or Rata Island of the Fernando de Noronha group (3,200 km away), the two closest other breeding colonies (Ashmole 1963b). Immature Masked boobies from St Helena have been observed on Ascension Island (E. Leat, pers. comm.) so it seems highly plausible that Red-footed Boobies may make similar journeys although they are smaller in size. In conclusion, additional research to remotely monitor future breeding attempts using an array of automatic, infra-red motion sensor cameras would allow us to verify breeding outcomes, while individual marking of breeding adults to enable identification, along with DNA sampling and analysis to assess their lineage, would be beneficial.

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