The populations and distribution of the breeding birds of the Socotra archipelago, Yemen: 1. Sandgrouse to Buntings

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This is the first of two papers on the distribution and population of the breeding birds of the Socotra archipelago, that have been studied in detail since 1999. It covers all the passerines and some non-passerines, including nine species that are endemic to the archipelago. A second paper will cover the remaining non-passerines. For each species there is a map showing breeding distribution, an estimate of the population based on a comprehensive series of transects, and brief notes on habitat and breeding biology. Of the 25 species covered many are widespread and occur in a variety of habitats, with the five most abundant being Socotra Sparrow *Passer insularis*, Black-crowned Sparrow-Lark *Eremopterix nigriceps*, Laughing Dove *Spilopelia senegalensis*, Somali Starling *Onychognathus blythii* and Long-billed Pipit *Anthus similis*. All 25 are resident, except for Forbes-Watson's Swift *Apus berliozi*. The only globally threatened species covered in this paper are the Abd Al Kuri Sparrow *Passer hemileucus* and Socotra Bunting *Emberiza socotrana* (both vulnerable), whilst the Socotra Cisticola *Cisticola haesitatus* is classified as near threatened.

INTRODUCTION

The Socotra archipelago (Figure 1) is famed for its unique flora and fauna, with over 350 species of endemic plants, at least 21 endemic reptiles and ten species of endemic birds (Cheung & DeVantier 2006, Porter & Suleiman 2011). For plant endemism per square kilometre alone Socotra island is ranked in the top ten islands in the world (Banfield *et al* 2011). This biological richness of the islands encouraged UNESCO to declare the Socotra archipelago a World Heritage Site in 2008.

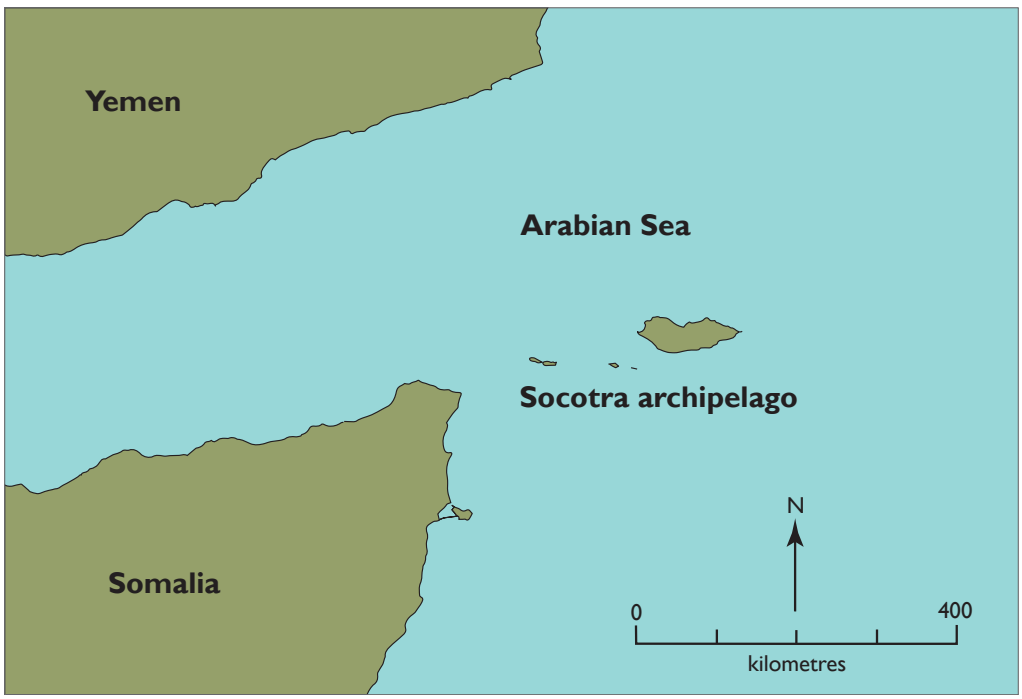

Figure 1. The Socotra archipelago. The archipelago consists of the main island, Socotra, and three satellite islands (Abd Al Kuri is about halfway between Socotra and the Horn of Africa) and several sea stacks.

Table 1. The breeding birds of the Socotra archipelago, Yemen. Species endemic to the archipelago and also those that have been classified as globally threatened (VU vulnerable, EN endangered) or near threatened (NT) by IUCN (BirdLife 2011) are indicated.

Persian Shearwater *Puffinus persicus*
Jouanin's Petrel *Bulweria fallax* (endemic breeder, NT)
Little Grebe *Tachybaptus ruficollis* (probably has bred)
Red-billed Tropicbird *Phaethon aethereus*
Yellow Bittern *Ixobrychus sinensis* (probably breeds).
Striated Heron *Butorides striata* (probably breeds)
Indian Pond Heron *Ardeola grayii* (may breed as present throughout year).
Western Cattle Egret *Bubulcus ibis* (may breed as present throughout year).
Masked Booby *Sula dactylatra*
Brown Booby *Sula leucogaster*
Socotra Cormorant *Phalacrocorax nigrogularis* (VU)
Western Osprey *Pandion haliaetus*
Egyptian Vulture *Neophron percnopterus* (EN)
Socotra Buzzard *Buteo socotraensis* (endemic, VU)
Common Kestrel *Falco tinnunculus*
Peregrine Falcon *Falco peregrinus*
Common Moorhen *Gallinula chloropus* (has bred at least once)
Black-winged Stilt *Himantopus himantopus*
Kentish Plover *Charadrius alexandrinus*
Cream-coloured Courser *Cursorius cursor*
Brown Noddy *Anous stolidus*
Sooty Gull *Larus hemprichii*
Saunders's Tern *Sternula saundersi*
Bridled Tern *Onychoprion anaethetus*
Lichtenstein's Sandgrouse *Pterocles lichtensteinii*
Feral Rock Dove *Columba livia* forma *domestica* (introduced)
Laughing Dove *Spilopelia senegalensis*
Bruce's Green Pigeon *Treron waalia*
White-browed Coucal *Centropus superciliosus*
Socotra Scops Owl *Otus socotranus* (endemic, taxonomy under review).
Nubian Nightjar *Caprimulgus nubicus*
Forbes-Watson's Swift *Apus berliozi* (near endemic)
Southern Grey Shrike *Lanius meridionalis*
House Crow *Corvus splendens* (accidentally introduced, bred, now eradicated)
Brown-necked Raven *Corvus ruficollis*
Black-crowned Sparrow-Lark *Eremopterix nigriceps*
Pale Crag Martin *Ptyonoprogne obsoleta*
Socotra Cisticola *Cisticola haesitatus* (endemic, NT)
Socotra Warbler *Cisticola incanus* (endemic)
Abyssinian White-eye *Zosterops abyssinicus*
Somali Starling *Onychognathus blythii*
Socotra Starling *Onychognathus frater* (endemic)
Socotra Sunbird *Chalcomitra balfouri* (endemic)
Socotra Sparrow *Passer insularis* (endemic)
Abd Al Kuri Sparrow *Passer hemileucus* (endemic, VU)
Long-billed Pipit *Anthus similis*
Socotra Golden-winged Grosbeak *Rhynchostruthus socotranus* (endemic)
Cinnamon-breasted Bunting *Emberiza tahapisi*
Socotra Bunting *Emberiza socotrana* (endemic, VU)

However, the archipelago has a rather species-poor avifauna. Of the 221 species recorded (Porter & Suleiman 2011) only 42 breed regularly (one of which, the feral form of the Rock Dove *Columba livia*, is introduced and domesticated), four others may breed or may have bred, one has bred at least once and one, accidentally introduced and a potential pest species, has now been eradicated. The full list is given in Table 1. Historically there have been claims of Lanner Falcon *Falco biarmicus* having been recorded, as well as an owl sounding like Hume's Owl *Strix butleri* (Forbes 1903, Jennings 2010). However during the extensive surveys of the last two decades neither has even been suspected.

Several dedicated visits to study the avifauna of Socotra have been made since the late 19th century: see *eg* Sclater & Hartlaub (1881), Forbes (1903) and Ripley & Bond (1966). However the first population studies were attempted during the OSME survey of 1993 (Davidson 1996, Kirwan *et al* 1996, Porter *et al* 1996). Then between 1999 and 2011 nine surveys (all between October and March) were undertaken by BirdLife International together with the then Socotra Conservation and Development Programme and Yemen's Environment Protection Authority to assess the distribution and population of the breeding birds of the archipelago. The first three of these visits were supported by UK's Darwin Initiative programme.

In this, the first of two papers that catalogue the populations and distributions of the breeding species, we cover 25 species: sandgrouse (Pteroclididae) to buntings (Emberizidae). We provided provisional population estimates for Jennings (2010). However we have since re-worked these data and, in several cases, have revised our estimates. Therefore the population data given in this paper supersedes those in Jennings (2010). We also give details, including the methodology used to determine our population estimates. For the endemics, habitat requirements and ecology have been adequately summarised in the species papers in Porter & Martins (1996) and for all species in the accounts in Jennings (2010).

THE ARCHIPELAGO, HABITATS AND CLIMATE

The Socotra archipelago (12.30° N, 54.00° E) is part of the Republic of Yemen. Situated east of the Horn of Africa and *c*350 km south of the Yemen mainland in the Arabian sea (Figure 1), it comprises the main island (Socotra, *c*3700 km^2), three satellite islands (Abd Al Kuri, Samha and Darsa) and several sea stacks. Rising to 1500 m asl in the granite Haggier mountains, much of the higher areas (500–1000 m asl) of Socotra are limestone. The main habitats of Socotra, adopted from Miller & Morris (2004), are mapped in Figure 2 and listed below.

- habitat type A: Semi-evergreen woodland of limestone escarpments and sheltered ravines (yellow in Figure 2, Plate 1)
- habitat type B: Open and woody-based herb communities on the limestone plateau (Figure 2 brown, Plates 2 & 3)
- habitat type C: Succulent shrubland on limestone cliffs and slopes (Figure 2 light green, Plates 4 & 5)
- habitat type D: *Croton* shrubland on the coastal plains (Figure 2 olive, Plates 6 & 7)

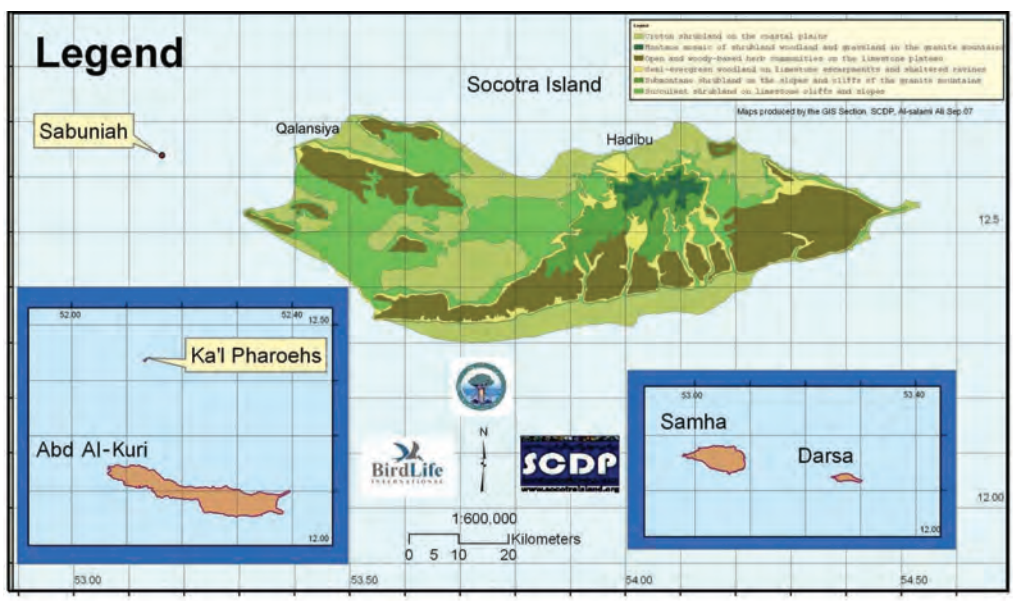

Figure 2. The Socotra archipelago showing the islands and the main habitat types on Socotra island. The habitat types are presented in the text (yellow on the map, habitat type A; brown, habitat type B; light green, habitat type C; olive, habitat type D; mid green, habitat type E; dark green, habitat type F). See also Table 3 which lists area in km^2 and % cover of each habitat.

Plate 1. Semi-evergreen woodland, Maqadrihon pass, Socotra, November 2008. © *Lisa Banfield*

Plate 2. Open and woody-based herb community on limestone, western Socotra, October 2007. © *Lisa Banfield*

Plate 3. Open and woody-based herb community on limestone, Qatariyah, Socotra, February 2007. © *Lisa Banfield*

Plate 4. Succulent shrubland on limestone cliffs and slopes, Dibini, Socotra, December 2007. © *Lisa Banfield*

Clockwise from left

Plate 5. Succulent shrubland, Qaysoh, Socotra, November 2007. © *Lisa Banfield*

Plate 6. *Croton* shrubland near Hadiboh, Socotra, February 2006. © *RF Porter*

Plate 7. *Croton* shrubland with mix of other trees, near Qalansiya, Socotra, October 2007. © *RF Porter*

- habitat type E: Submontane shrubland on the slopes and cliffs of the granite mountains (Figure 2 mid green, Plate 8)
- habitat type F: Montane mosaic of shrubland and woodland and grassland in the granite mountains (Figure 2 dark green, Plate 9)
- habitat type G: Dwarf coastal vegetation: mosaic of low succulent shrubs and woody-based herbs; species composition varying but variably dominated by *Limonium*, *Zygophyllum*, *Suaeda*, *Indigofera*, *Pulicaria* and *Atriplex* species (not shown in Figure 2, Plate 10)
- Palm groves, also not mapped in Figure 2, deserve mention. This planted habitat, which covers a very small area of *c*8 km^2 (Lisa Banfield *in litt*), is mainly confined to areas close to the main towns of Habibu and Qalansiya and the edges of the larger wadis. It is an important breeding habitat for Bruce's Green Pigeon *Treron waalia* and Socotra Scops Owl *Otus socotranus.*

Other than coastal waters, creeks and a coastal lagoon at Qalansiya, wetlands are not a feature of the Socotran landscape.

The climate of the archipelago is monsoonal (see Miller & Morris 2004). During the hot dry southwest summer monsoon, which lasts May–September, winds reach an average of over 60 km/h for 50% of the time. The winds of the northeast monsoon (November–March) are much milder and bring the winter rains, which can be torrential. The spring transitional period March–May, between the monsoons, brings more gentle rains

Plate 8. Submontane shrubland, Wadi Di Negehan, Socotra, February 2010. © *Lisa Banfield*

Plate 9. Montane mosaic, Skand, Socotra, January 2008. © *Lisa Banfield*

Plate 10. Dwarf coastal vegetation, Noged plain, Socotra, February 2004. © *RF Porter*

though this can be the hottest period of the year; whilst the autumn transitional period (September–October) is very dry before the autumn rains start. Our studies have shown that the breeding season for land birds starts at the end of the latter period, in October. For most species the breeding season continues until March/April, just before the onset of the southwest monsoon.

Other than livestock (sheep, goats and miniature cattle), which were introduced by man, there are no larger mammals on Socotra other than the introduced Lesser Indian Civet *Viverricula indica*. Furthermore there is no evidence of any historical extinctions nor of large mammals ever having been part of the Socotran fauna. Rats have been introduced and are evident in Hadiboh and Qalansiya towns (Van Damme & Banfield 2011).

METHODS

Breeding distribution

The islands were divided into 1/10th degree recording 'squares', each *c*120 km^2. Figure 3 shows the recording squares for the main island of Socotra. From 1999–2011 each square was visited at least twice (and at least half on over ten occasions) to search for proof of breeding of all species. All visits were made between October and April, the main breeding period, and none during the dry monsoon season May–September. The observers who helped with these surveys are named in the acknowledgements.

Eight of the main island's recording squares are >95% sea and thus few or no visits were made to squares N4, N6, O3, Q3, W7 and X4 which have little terrestrial vegetation cover. Much of the fieldwork was carried out in week-long camping expeditions away from the capital Hadiboh. Location of the 10 km recording squares was determined by GPS. In addition to establishing proof of breeding all squares visited were the subject

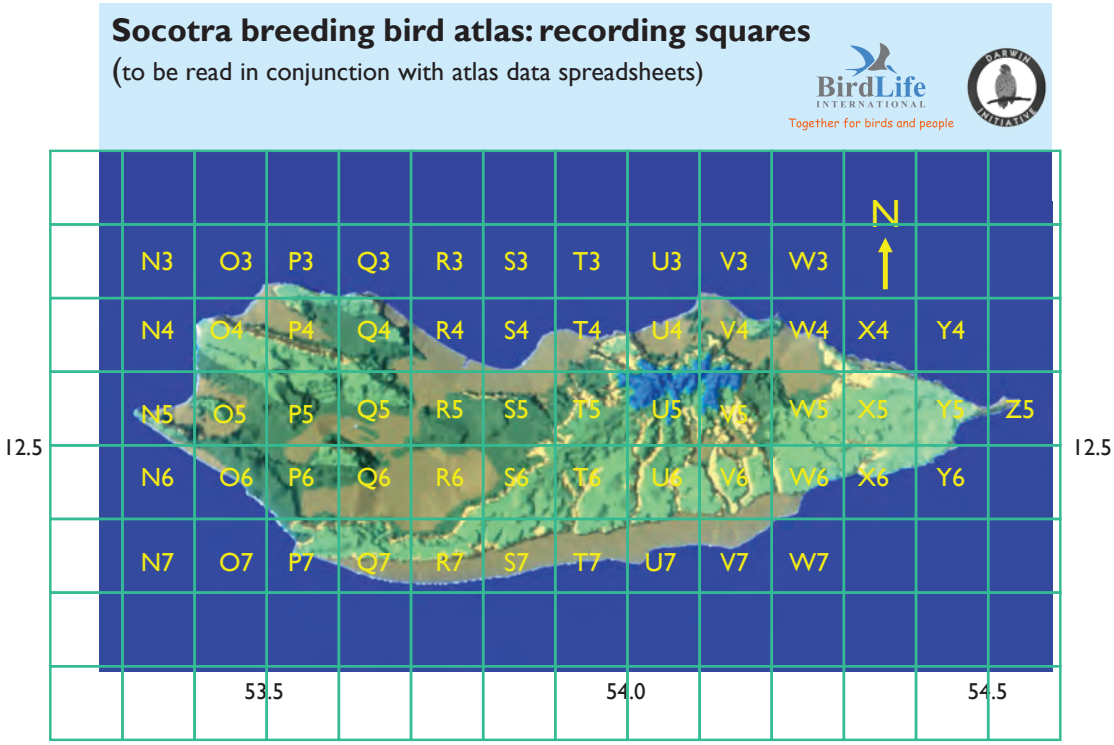

Figure 3. Socotra showing recording squares (see text).

of timed transects to obtain population estimates (see below). Three visits were made to each of Abd Al Kuri, Samha and Darsa islands (Figures 1, 2) whilst undertaking seabird censuses.

Following Gibbons *et al* (1993) two categories of breeding were adopted and are shown on the distribution maps, Figures 4–26, as: (1) large dots, breeding proven, that indicate evidence of breeding was obtained, including both 'confirmed' and 'probable' and (2) small dots, probably breeding, where birds were present in potential breeding habitat but without more direct evidence of breeding. A summary of breeding definitions under these categories is given in Table 2. It was considered sensible to combine the two categories 'confirmed' and 'probable' used separately by others *eg* Sharrock (1976) to reflect *proof* of breeding for reasons outlined in Gibbons *et al* (1993). A breeding distribution map is given for each species except feral Rock Dove *Columba livia* and House Crow *Corvus splendens*. Maps for Abd Al Kuri, Samha and Darsa islands are included only when breeding has been proven or is probable on at least one of these islands. On the map for Forbes-Watson's Swift *Apus berliozi* (Figure 10), unlike all the other distribution maps, small dots indicate squares where the species was observed but breeding was not suspected.

Population size assessments

A second aim was to assess the populations of breeding birds. It will be seen from the distribution maps that many species are widespread or fairly widespread. For these we recorded birds along transects of a fixed band width as the basis for estimating their populations. Transects were undertaken throughout the island covering nearly all recording squares, all habitat types and all altitude ranges (see Tables 3 and 4). The band

Table 2. Breeding distribution on Socotra: categories used to determine breeding proven (large dots in Figures 4–26) and probably breeding (small dots) (adapted from British Trust for Ornithology guidelines, see BTO 2012). Breeding proven = BTO categories 'Probable breeding' and 'Confirmed breeding'. Probably breeding = BTO category 'Possible breeding'. See Methods for rationale.

'Possible breeding'
Species observed in breeding season in suitable nesting habitat
Singing male present (or breeding calls heard) in breeding season in suitable breeding habitat
'Probable breeding'
Pair observed in suitable nesting habitat in breeding season
Permanent territory presumed through territorial behaviour and song on at least two different days a week or more apart at the same place or many individuals on one day
Courtship and display (in potential breeding habitat)
Visiting probable nest site
Agitated behaviour or anxiety calls from adults, suggesting probable presence of nest or young nearby
Brood patch on adult examined in the hand, suggesting incubation
Nest building
'Confirmed breeding'
Distraction display
Used nest or eggshells found
Recently fledged young/adults feeding fledged young.
Adults entering or leaving nest-site in circumstances indicating occupied nest
Adult carrying faecal sac or food for young
Nest containing eggs
Nest with young seen or heard

width chosen was 60 m (*ie* 30 m each side of the transect line) with the exception of Brown-necked Raven *Corvus ruficollis* where a 200 m band width was chosen. For some species the transect census technique was not appropriate. Thus more targeted methods were used for domesticated Rock Dove, Socotra Scops Owl, Nubian Nightjar *Caprimulgus nubicus*, Forbes-Watson's Swift, Pale Crag Martin *Ptyonoprogne* (*fuligula*) *obsoleta*, Socotra Cisticola *Cisticola haesitatus* and Abd Al Kuri Sparrow *Passer hemileucus*, details of which are given in the species accounts.

Transect methodology

Transect sites were chosen randomly, while at the same time attempting to ensure that all habitat types were represented. Some parts of the island were difficult to access. Table 3 shows the coverage achieved. For each transect, an observer would walk a measured distance of a minimum of one km in as straight a line as possible recording all birds of all species seen or heard within the defined band width. If terrain permitted, distances of two or more kilometres were covered. Species that were known migrants and birds flying overhead were ignored. To assist with analysis, transects were only conducted within a particular habitat type, and not through mixed habitat types. Determination of the length surveyed was checked by GPS. Usually, one km would be covered during *c*20 minutes of walking, in all habitats types and in most terrains; on steeper slopes this was nearer 30 minutes. Where two or more observers were undertaking transects, care was taken to ensure their counts did not overlap. This was best achieved by radiating out from a central point.

At each transect site the following were noted: atlas recording square, date, GPS co-ordinates, locality, altitude, length of transect and habitat. This information was

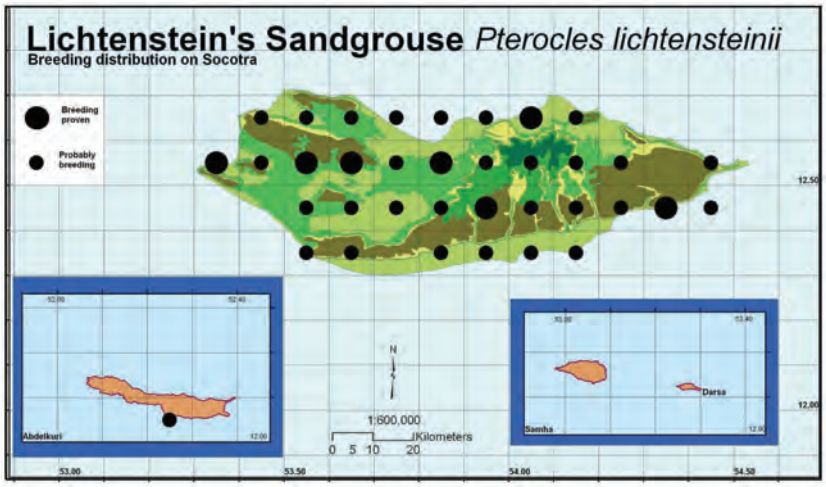

Figure 4. Lichtenstein's Sandgrouse: Socotran breeding distribution.

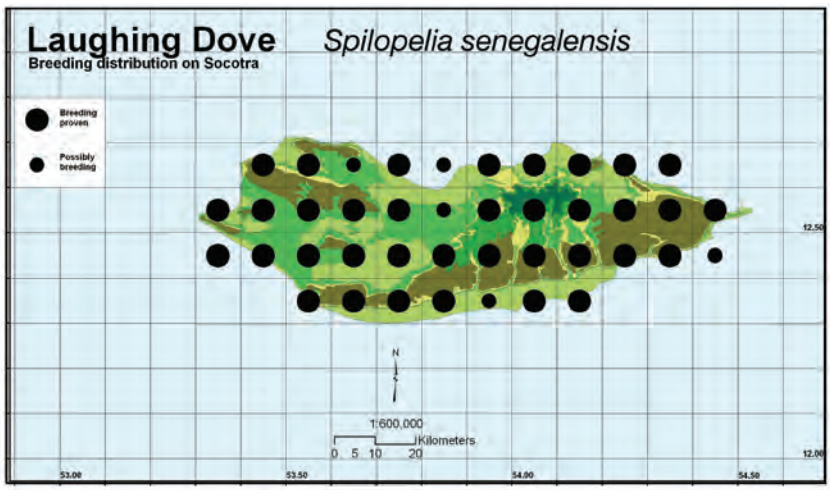

Figure 5. Laughing Dove: Socotran breeding distribution. The small dots indicate *probably* breeding (see Methods) contrary to the in-map key.

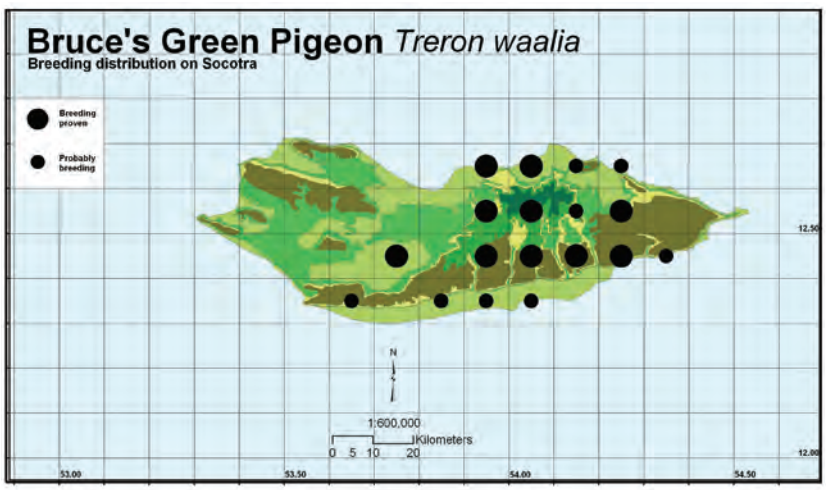

Figure 6. Bruce's Green Pigeon: Socotran breeding distribution.

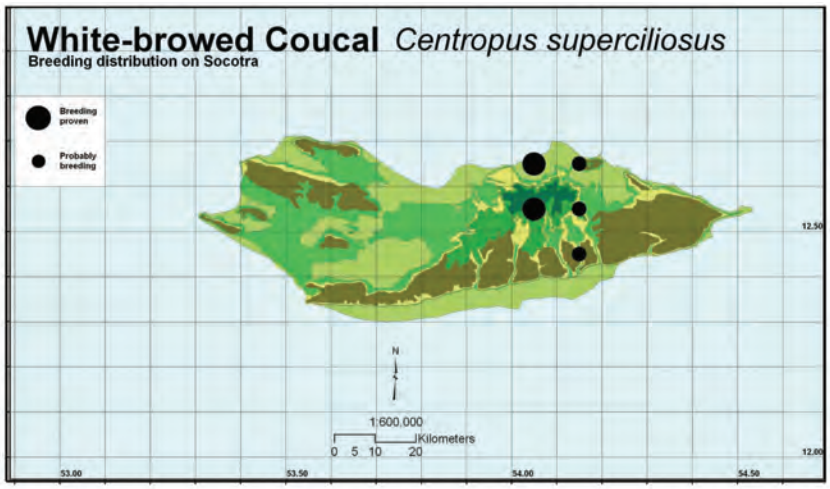

Figure 7. White-browed Coucal: Socotran breeding distribution.

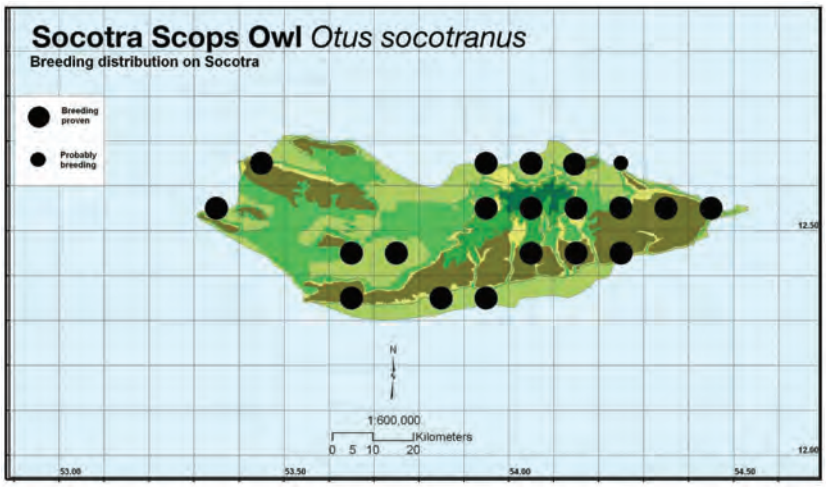

Figure 8. Socotra Scops Owl: Socotran breeding distribution.

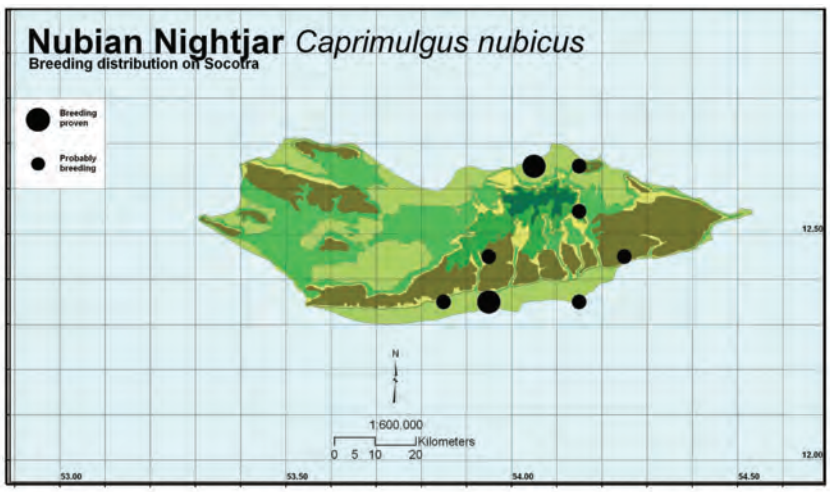

Figure 9. Nubian Nightjar: Socotran breeding distribution.

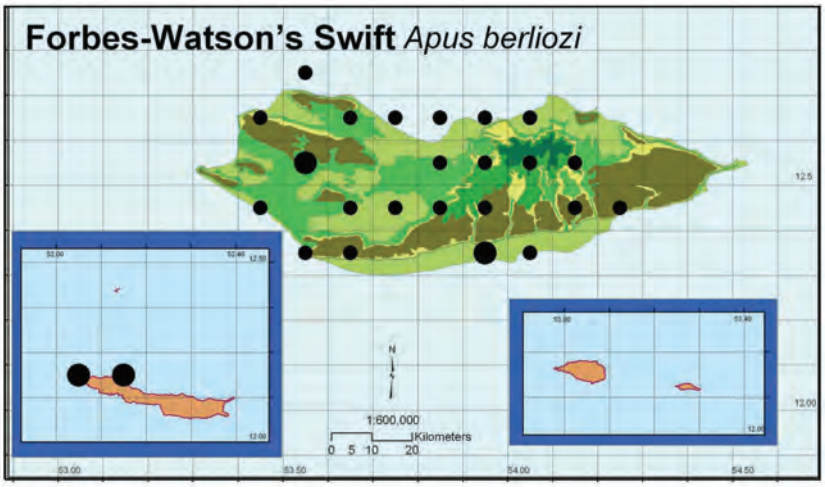

Figure 10. Forbes-Watson's Swift: Socotran breeding distribution. Large dots: breeding proven, small dots (a different meaning for this map only): squares where observed, but breeding was not suspected.

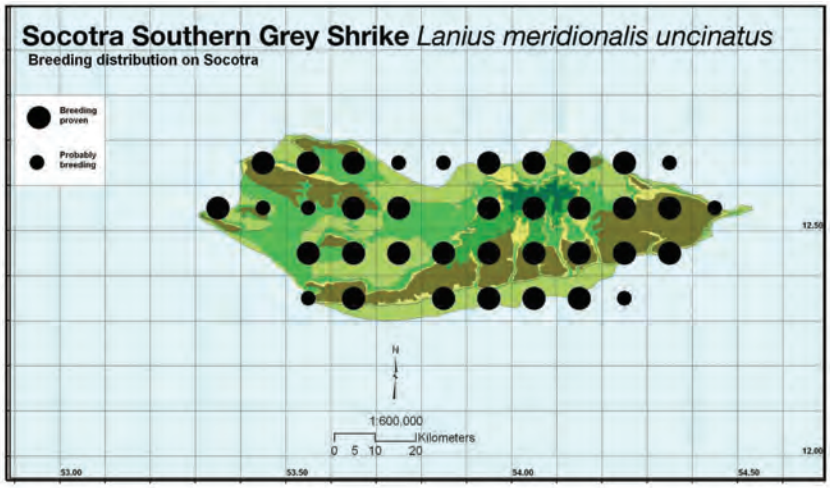

Figure 11. Socotra Southern Grey Shrike: Socotran breeding distribution.

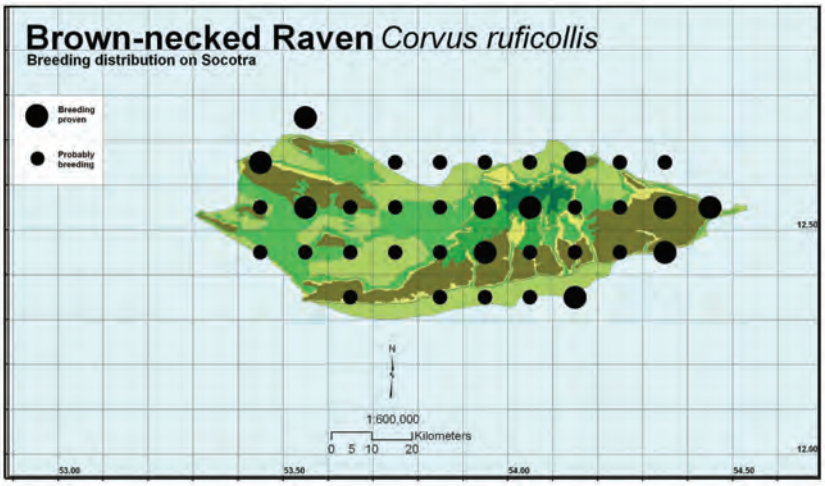

Figure 12. Brown-necked Raven: Socotran breeding distribution.

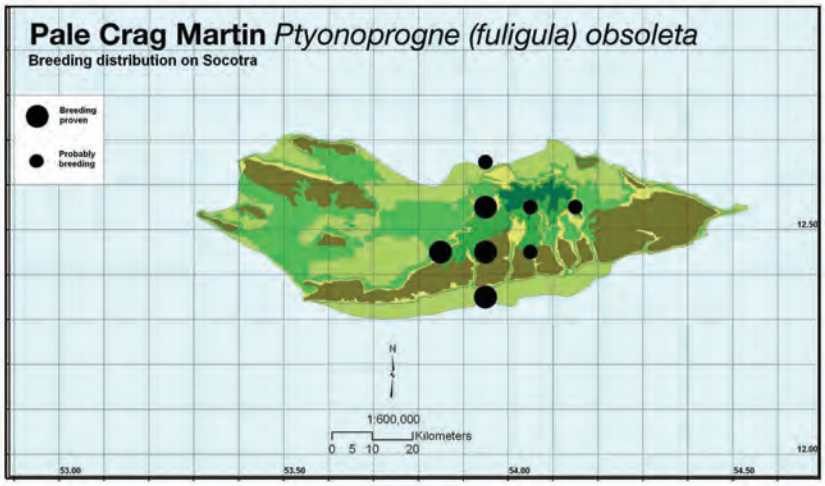

Figure 13. Pale Crag Martin: Socotran breeding distribution.

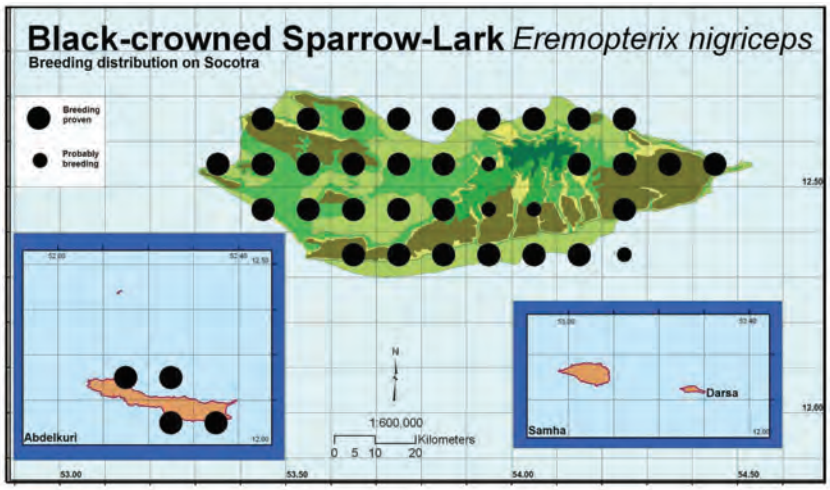

Figure 14. Black-crowned Sparrow-Lark: Socotran breeding distribution.

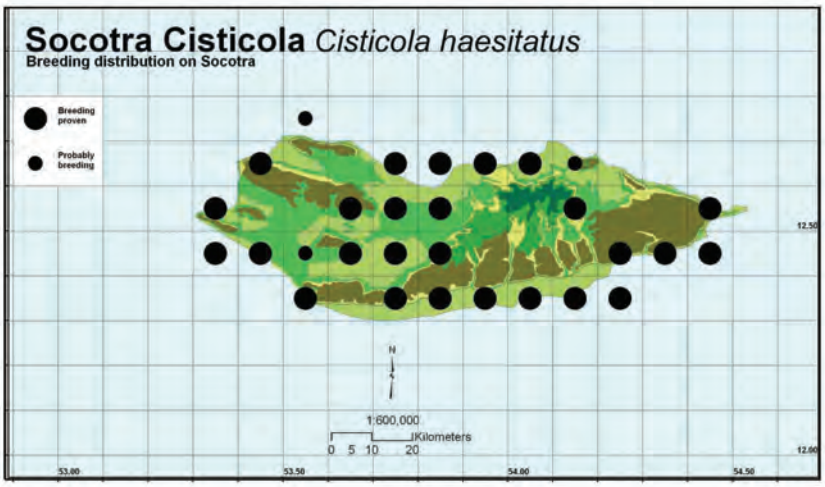

Figure 15. Socotra Cisticola: Socotran breeding distribution.

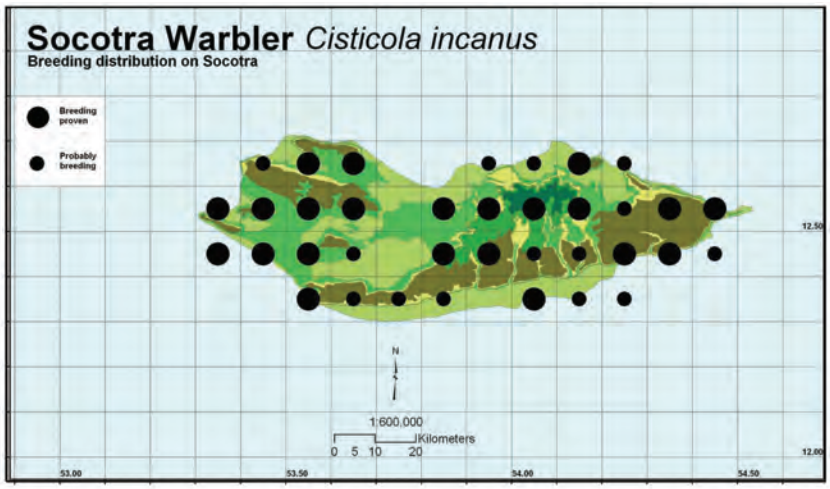

Figure 16. Socotra Warbler: Socotran breeding distribution.

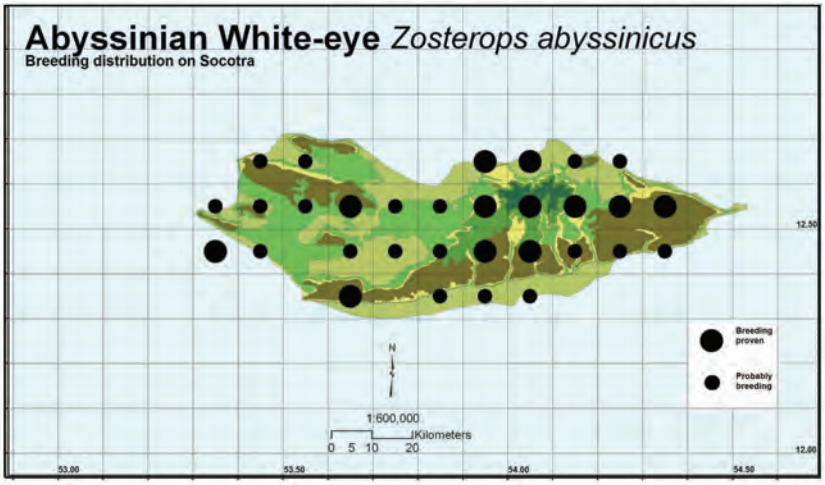

Figure 17. Abyssinian White-eye: Socotran breeding distribution.

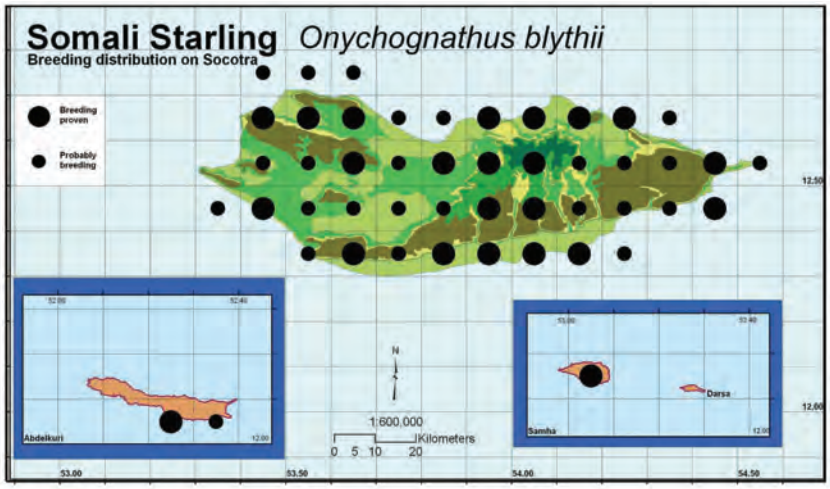

Figure 18. Somali Starling: Socotran breeding distribution.

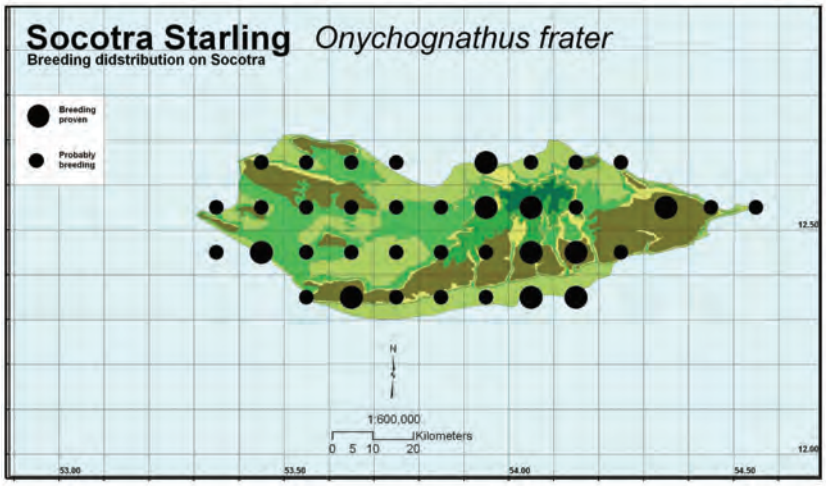

Figure 19.
Socotra Starling: Socotran breeding distribution.

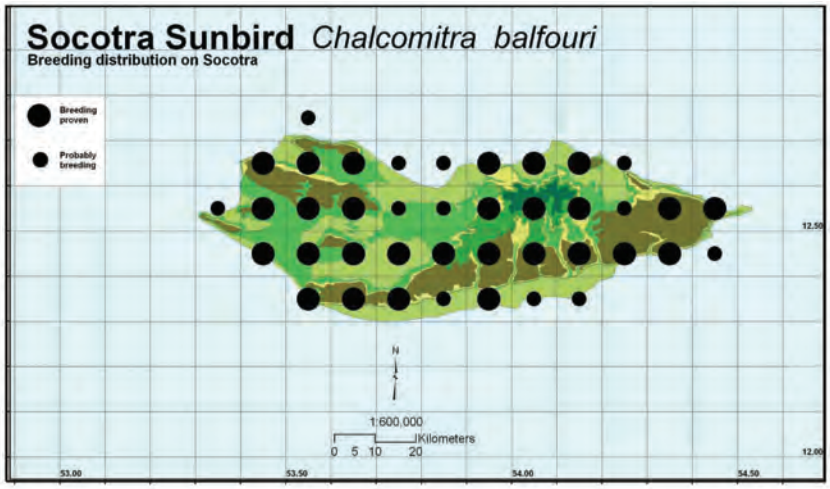

Figure 20.
Socotra Sunbird: Socotran breeding distribution.

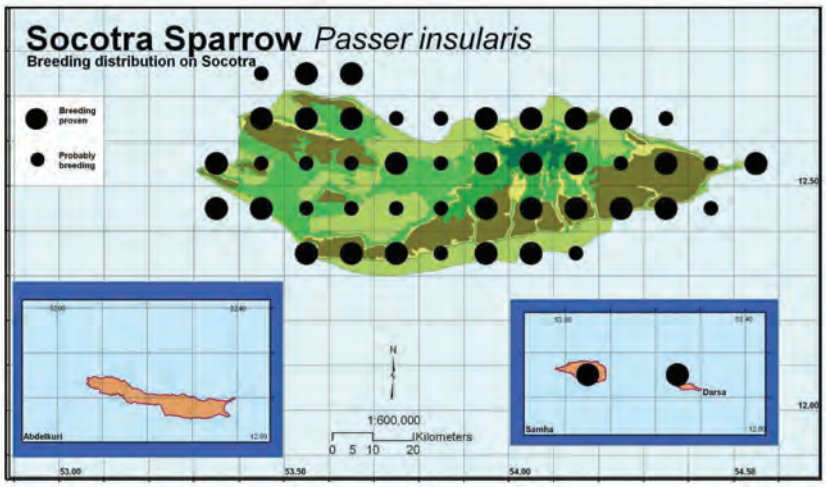

Figure 21.
Socotra Sparrow: Socotran breeding distribution.

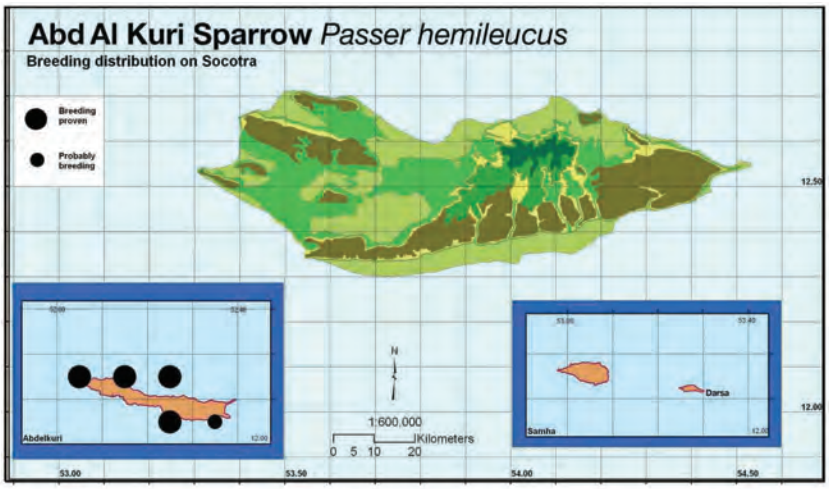

Figure 22. Abd Al Kuri Sparrow: Socotran breeding distribution.

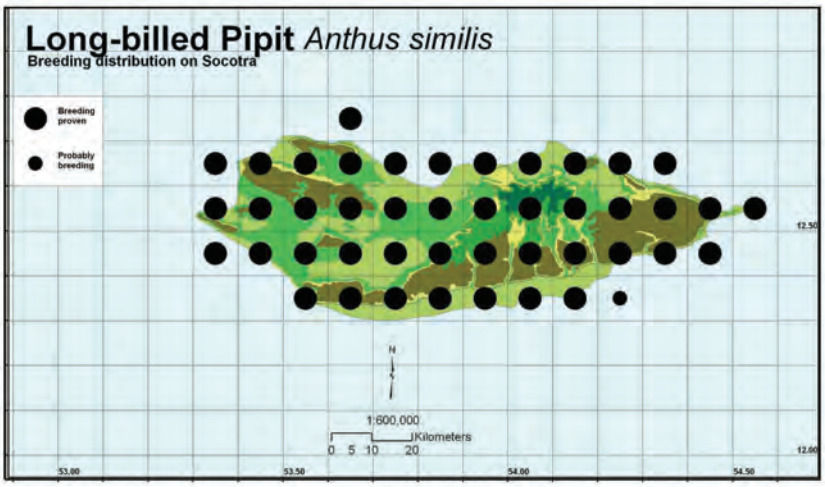

Figure 23. Long-billed Pipit: Socotran breeding distribution.

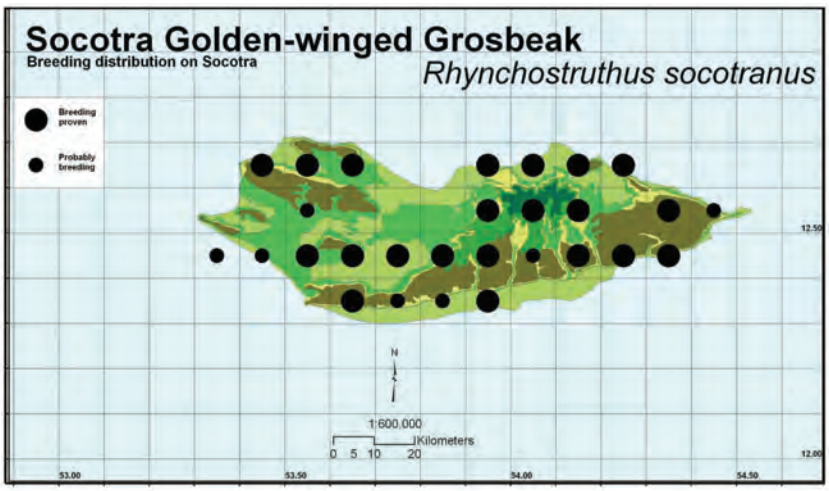

Figure 24. Socotra Golden-winged Grosbeak: Socotran breeding distribution.

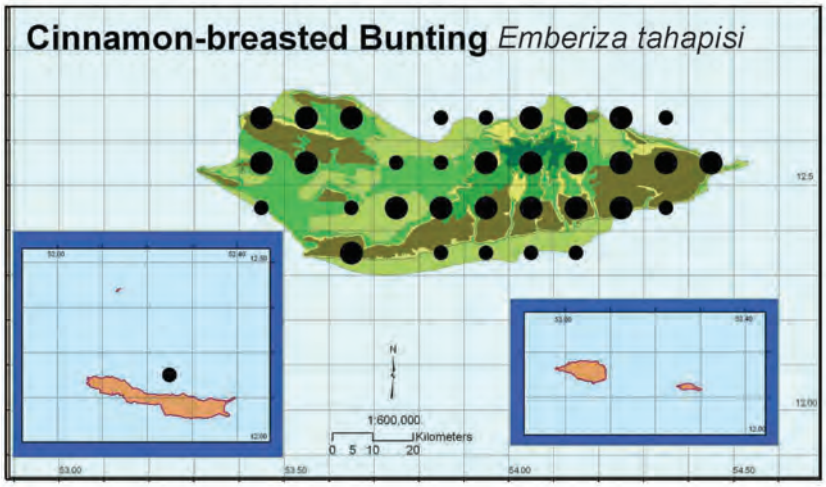

Figure 25. Cinnamon-breasted Bunting: Socotran breeding distribution. Large dots indicate breeding proven, small dots probably breeding.

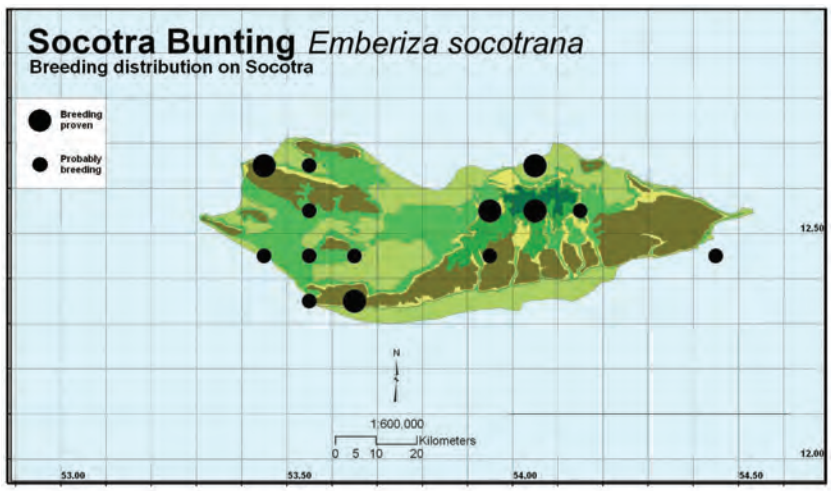

Figure 26. Socotra Bunting: Socotran breeding distribution

recorded on an Excel spreadsheet. A total of 385.5 km of transects were undertaken 1999–2008 throughout Socotra island as follows: 79 km in 10 recording squares November 1999, 130.75 km in 17 recording squares February and March 2000, 6 km in 4 recording squares April 2000, 38.5 km in 9 recording squares February 2001, 47.5 km in 6 recording squares February 2004, 10.5 km in 3 recording squares February and March 2006, 20 km in 4 recording squares February and March 2007, 22.5 km in 8 recording squares October and November 2007, 30.75 km in 6 recording squares October and November 2008. Transects were undertaken in 36 of the 43 recording squares that were over 90% land, and, as comprehensively as possible, in the seven main habitats (Table 3) and at all altitude ranges (Table 4), though we are aware from the coverage that habitats A and C were probably under sampled.

The results from line transects will inevitably contain biases, notably those caused by observer ability (see *eg* Porter 2012), measurement of transect length and band width, assigning a transect to a habitat type (as there is sometimes a 'grey area' between types), and species' detectability. In the case of the latter, this could be influenced by

Table 3. The main habitats on Socotra, their area and length of transects undertaken in each.

HABITAT	Approx % of island	Area of island km^2	Total length of transects undertaken km	% of habitat sampled
A. Semi-evergreen woodland of limestone escarpments and sheltered ravines (mostly *c*500–700 m)	8%	293	14	0.3
B. Open and woody-based herb communities on the limestone plateau (*c*500–720 m)	27%	1003	114.5	0.7
C.Succulent shrubland on limestone cliffs and slopes (0–550 m)	28%	1041	66.5	0.4
D. Croton shrubland on the coastal plains (mostly <50 m)	29%	1087	108.5	0.6
E. Submontane shrubland on the slopes and cliffs of the granite mountains (*c*380–750 m)	5%	190	27	0.9
F. Montane mosaic of shrubland woodland and grassland in the granite mountains (> 750 m)	2%	73	13	1.0
G. Dwarf coastal vegetation: mosaic of low succulent shrubs and woody-based herbs, variously dominated by *Limonium*, *Zygophyllum*, *Suaeda* and *Pulicaria* (<50 m)	<1%	30	42	8.4

vegetation density as well as behavioural and vocal activity of species. The use of distance estimation has become standard practice in most transect surveys which can also be used to correct for attenuation of song/calls which differ between habitats and species (*eg* Newson *et al* 2005). However, a more straightforward approach was adopted here which we felt was more easily replicated across the habitat types present with different observers. Furthermore the habitats on the islands generally show a rather open structure, the number of breeding species is low (compared *eg* with a European woodland habitat) and none of the species is secretive in behaviour. We felt confident, therefore, that detectability rates of most species were high. We are aware that the detectability of species may vary through the breeding season, but without knowing the behaviour of the species concerned, it is difficult to correct for this but this might be a bias as counts in different places were conducted at different stages of the breeding season. However, we believe that the spread of transects throughout the season will have helped to cushion this.

Table 4. Length of transects (km) undertaken in each quarter (NW quarter = W of 53.80° E, N of 12.50° N *etc*) and altitude range (asl) on Socotra.

	below 250 m	250–750 m	above 750 m
NW quarter	53	64	7
NE quarter	41	44	13.5
SW quarter	54	8	-
SE quarter	65	32	5

Calculating population estimates

To establish population estimates, the range and density of each species were determined. First, as described under 'Breeding distribution' all recording squares were visited to establish whether a species was probably or proven to be breeding. These squares were used to represent the 'breeding range' of each species. Second, based on the transect methodology previously described, the density of each species, in each habitat within the species range was calculated.

Table 5. Densities (birds/km²) in each of the seven habitat types on Socotra (see Table 3 for definitions) for those species whose population was determined by transects. The 95% confidence intervals are given in parenthesis.

		Habitat type						
		A	B	C	D	E	F	G
Lichtenstein's Sandgrouse	*Pterocles lichtensteinii*	0	0	1.50 (0.41–5.54)	1.16 (0.45–2.95)	0	0	0.48 (0.06–3.78)
Laughing Dove	*Spilopelia senegalensis*	108 (52.8–222)	34.2 (22.3–52.4)	48.9 (32.7–73.0)	43.2 (26.9–69.3)	46.3 (27.9–76.9)	30.8 (13.3–71.2)	9.72 (4.91–19.2)
Bruce's Green Pigeon	*Treron waalia*	20.2 (8.30–49.3)	3.01 (0.54–16.9)	7.21 (2.38–21.9)	1.39 (0.20–9.69)	2.00 (0.37–10.9)	5.13 (1.31–20.1)	0
Southern Grey Shrike	*Lanius meridionalis*	17.9 (14.2–22.4)	6.40 (4.22–9.73)	5.60 (3.16–9.92)	8.62 (6.16–12.1)	8.02 (4.02–16.0)	12.8 (3.05–53.8)	5.16 (3.40–7.85)
Brown-necked Raven	*Corvus ruficollis*	1.43 (0.36–5.69)	0.24 (0.08–0.74)	0.49 (0.15–1.56)	0.27 (0.11–0.70)	0.93 (0.22–3.99)	1.15 (0.25–5.38)	0.67 (0.11–4.19)
Black-crowned Sparrow-Lark	*Eremopterix nigriceps*	0	34.9 (11.9–102)	48.0 (18.0–128)	114 (67.5–193)	4.86 (0.56–42.0)	0	76.3 (32.8–177)
Socotra Warbler	*Cisticola incanus*	0	7.71 (4.11–14.5)	13.5 (7.74–23.7)	2.73 (1.15–6.49)	19.1 (10.7–34.4)	16.7 (7.46–37.2)	7.76 (3.00–20.1)
Abyssinian White-eye	*Zosterops abyssinicus*	53.6 (32.0–89.8)	2.99 (1.22–7.28)	6.25 (2.84–13.8)	1.72 (0.42–7.08)	17.3 (7.15–41.8)	24.4 (6.34–93.6)	2.61 (0.27–25.2)
Somali Starling	*Onychognathus blythii*	114 (27.4–476)	31.3 (18.8–52.1)	10.3 (4.98–21.2)	17.8 (11.8–26.9)	45.7 (28.6–73.1)	32.1 (18.2–56.5)	3.17 (0.58–17.3)
Socotra Starling	*Onychognathus frater*	8.33 (0.55–125)	5.41 (2.97–9.85)	6.77 (2.82–16.2)	7.22 (2.80–18.6)	20.4 (7.83–53.0)	10.3 (3.76–27.9)	0
Socotra Sunbird	*Chalcomitra balfouri*	28.6 (13.0–62.6)	22.1 (13.9–35.3)	22.3 (12.4–40.2)	11.0 (6.09–19.8)	24.1 (9.66–60.0)	1.28 (0.15–11.1)	1.28 (0.15–10.8)
Socotra Sparrow	*Passer insularis*	92.9 (23.2–372)	134 (65.6–274)	100 (74.3–135)	50.7 (32.4–79.2)	95.1 (53.1–170)	39.7 (16.2–97.4)	28.7 (7.62–108)
Long-billed Pipit	*Anthus similis*	7.14 (0.95–53.6)	39.7 (28.9–54.6)	17.3 (11.8–25.4)	31.3 (23.4–42.0)	14.8 (4.19–52.3)	14.1 (7.04–28.3)	20.6 (12.4–34.2)
Socotra Golden-winged Grosbeak	*Rhynchostruthus socotranus*	15.5 (2.19–109)	2.13 (0.97–4.72)	6.55 (2.13–20.2)	5.67 (2.65–12.1)	9.88 (4.22–23.1)	11.5 (5.82–22.9)	2.08 (0.15–29.4)
Cinnamon-breasted Bunting	*Emberiza tahapisi*	17.9 (1.44–221)	30.0 (18.6–48.2)	6.00 (1.52–23.7)	3.31 (1.06–10.3)	13.6 (6.32–29.2)	0	0
Socotra Bunting	*Emberiza socotrana*	0	4.55 (1.41–14.7)	1.10 (0.18–6.64)	0	12.0 (1.96–73.4)	0	0

Data analysis

Estimates of density and abundance and associated 95% confidence intervals were estimated within the program DISTANCE (Thomas *et al* 2010). Here abundance in each habitat is estimated by:

$$\hat{N} = A\frac{n}{2wL}$$

Where, for each habitat, A is the total habitat area within the species range, $2w$ is the strip width (band width, corresponding to a distance, w, each side of the transect line), L is the total transect length and n the number of individuals counted. Confidence intervals (CI) are lognormal confidence intervals based on equations 3.71–3.74 in Buckland *et al* (2001), except that the normal distribution percentile is replaced with a t-distribution percentile,

where the degrees of freedom are based on a method due to Satterthwaite (1946). The methodology for determining the populations of species where a transect-based analysis is inappropriate is given in the specific species' account.

We have not attempted to translate number of individuals into pairs because of lack of data on the territorial behaviour and breeding biology of the species included in this paper. It is considered safest by many modern day workers to present transect results as density of individuals rather than convert into 'pairs'. This avoids having to make assumptions about non breeders, or whether individuals actually are paired and it also circumvents problems concerned with species-specific detectability (Rob Fuller pers comm). We have also given, in Table 5, densities (in birds/km^2) in each of the seven habitat types (these are listed in Table 3) for those species whose populations were determined by transects, together with the 95% confidence intervals. In the species accounts below we have indicated which species are endemic to the archipelago and also those that have been classified as globally threatened (VU vulnerable) or near threatened (NT) by IUCN (BirdLife 2011).

SPECIES ACCOUNTS

Lichtenstein's Sandgrouse *Pterocles lichtensteinii* (Figure 4, Plate 11). This, the only sandgrouse to occur in the archipelago, is widespread on Socotra below 200 m asl. The highest counts at three drinking pools at dusk were 100, 50 and 30. Analysis of the transect data shows a population of 2226 individuals (95% CI 970–5109, Table 5 gives density in each habitat type). Song has been recorded 15 November–19 March, nests with eggs (2 × c/2, 1 × c/3) 28 November–11 March, nest with chicks (2 chicks) on 29 February and

Plate 11. Male Lichtenstein's Sandgrouse *Pterocles lichtensteinii*, Socotra, March 2006. © *RF Porter*

adults with young 13 March–23 April. Thus the breeding season would appear to be mid November–late April. Lichtenstein's Sandgrouse has also been recorded on Abd Al Kuri.

Feral Rock Dove *Columba livia.* Up to eleven 'domesticated' birds were recorded in Hadiboh town 1999–2011; they could frequently be seen flying around together as a group and had presumably been brought over from the mainland of Yemen. In addition, what appeared to be pure Rock Doves were seen and photographed at the coastal cliffs of Ras Hebak, 5 km west of Hadiboh, in 1999, 2000 and 2008, with up to six birds present.

Laughing Dove *Spilopelia senegalensis* (Figure 5, Plate 12). Laughing Dove has the widest breeding distribution of any species on Socotra, but it is not found on the other islands in the archipelago. After the Socotra Sparrow and Black-crowned Sparrow-Lark it is the third commonest breeding bird. It occurs in all main habitat types (see Table 3) except for dwarf coastal vegetation, and at altitudes 0–1000 m asl. Analysis of the transect data shows a population of 166 690 individuals (95% CI 135 870–204 500). Table 5 gives the density in each habitat type and shows that the highest density, 108 birds/km^2, was recorded in the semi-evergreen woodland of limestone escarpments and sheltered ravines (habitat type A). Song has been recorded November–April, nests with eggs (4 × c/2; 1 × c/1) 17 November–14 June and recently fledged young until June. Thus the known breeding season is November–June, one of the longest of any bird on Socotra.

Plate 12. Laughing Dove *Spilopelia senegalensis*, Socotra, February 2004. © *RF Porter*

Plate 13. Bruce's Green Pigeon *Treron waalia* nest, Socotra, February 2011. © *RF Porter*

Bruce's Green Pigeon *Treron waalia* (Figure 6, Plate 13). This pigeon is only recorded in the archipelago on Socotra where it occurs mainly in the eastern part, especially favouring stands and groves of palms at lower altitudes but also up to 1100 m asl in the Haggier mountains in montane thickets. Analysis of the transect data shows a population of 7947 individuals (95% CI 4787–13 192). Although no dedicated surveys were made in palm woodland, which totals <8 km^2, even a density of 50 birds/km^2, would only add a further 400 individuals. Thus a better population estimate would be *c*8350. Song and display has been recorded 13 November–16 March, a nest with two eggs was found in December and another, with two eggs, early March. A nest with one young was found in February and another, again with one young, in March.

White-browed Coucal *Centropus superciliosus* (Figure 7, Plate 14). This species only occurs on the main island. Because of the low density, highly secretive behaviour and localised distribution it is very difficult to census. Analysis based on transects indicate a

Plate 14. White-browed Coucal *Centropus superciliosus*, Socotra, February 2009. © *Rob Felix*

population of *c*550 individuals, however this should be treated with great caution as only two encounters were made, both of singing birds—presumably males on territory. In our opinion the population of this rarely seen bird is probably less than 100 pairs. During transects and the atlas surveys White-browed Coucals were located in five of the recording squares (12% of the island) and were confined to areas of overgrown date palm groves at low altitude and to the wooded sub-montane slopes of the Haggier mountains at *c*1000 m asl. Song was recorded 20 November–23 February, fledged young in December and adults carrying food to young in a nest in February. The breeding season therefore would appear to be November–February.

Socotra Scops Owl *Otus socotranus* (endemic, Figure 8, Plates 15, 16). This species is found in *c*45% of the area of Socotra and is the only breeding owl. Unsurprisingly none were encountered

Plate 15. Young Socotra Scops Owls *Otus socotranus*, Socotra, February 2011. © *AS Suleiman*

during transects but night time surveys showed it could be quite common in areas where there were good stands of mature trees, especially palms. They were recorded up to 850 m asl. Birds appeared to be most numerous in recording squares T5, U4, V5 and W5 where night surveys suggested a density of up to three birds singing/km^2. Extrapolation is perhaps unwise but it would not be unreasonable to suggest each recording square where birds were present held over 50 pairs, indicating a Socotra population of *c*1000 pairs. Song was recorded 26 October–3 April; two young in a nest on 19 February (estimated at *c*20 days old suggesting a laying date of 4/5 January) and recently fledged young (brood sizes of 1, 3 and 4) were found 16 February–mid April. The taxonomic position and affinities of this owl are currently under investigation (Pons *et al* in prep).

Plate 16. Recently fledged Socotra Scops Owl *Otus socotranus*, Socotra, March 2011. © *RF Porter*

Nubian Nightjar *Caprimulgus nubicus* (Figure 9, Plate 17). This nightjar occurs on Socotra, where birds were observed in eight of the recording squares (*c*20% of the island) mostly on sparsely vegetated sandy and gravelly plains, often with *Croton*, below 100 m asl. However only one bird was encountered on transects and it clearly would be unsafe to use this in an analysis to determine the population. Targeted dusk surveys in areas that it occurs show that it is not uncommon and it would not be unreasonable to assume a population of <100 pairs. There is very little information on the duration of the breeding season but birds have been recorded in territorial display and singing November–February.

Plate 17. Nubian Nightjar *Caprimulgus nubicus*, Socotra, November 1999. © *Simon Aspinall*

Forbes-Watson's Swift *Apus berliozi* (near-endemic, Figure 10, Plate 18). This is the only migrant 'land bird' that breeds in the archipelago and is difficult to census meaningfully. It can be seen over much of Socotra but somewhat unpredictably; in some years it is much commoner than others with 600 the largest flock observed. Birds have been recorded flying over 23 (*c*60%) of the recording squares on Socotra, but breeding was suspected in only two squares, where birds were watched repeatedly entering caves in the limestone cliffs—at sea level and at *c*500 m asl. During transects flying birds were counted using a 200 m band width and whilst the interpretation of such observations of a mobile bird is unwise, analysis indicates a population in excess of 2400 birds. However, it would be safer to say

the breeding population is unknown and that the number of individuals in any one year is unlikely to exceed 1000 on the main island. It has also been recorded breeding on Abd Al Kuri.

The migration pattern and breeding biology of this swift are difficult to interpret. Screaming and display flights have been regularly observed in February and March and birds have been seen entering nesting caves late February–May, which is presumably the breeding season. None have been recorded June–September when the monsoon is at its height, but this may be because of the difficulty of observations during that time; none have been seen 20 December–19 February when it is probably genuinely absent from the archipelago.

Plate 18. Forbes-Watson's Swift *Apus berliozi*, Samha, March 2007. © *Peter Ryan*

Socotra Southern Grey Shrike *Lanius meridionalis uncinatus* (endemic race, Figure 11, Plate 19). This shrike only breeds on the main island where it is widespread in all habitats with trees from 0–1500 m asl. Its breeding distribution encompassed 37 of the recording squares (*c*90% of Socotra). Analysis of the transect data shows a population of 25 993 individuals (95% CI 21 734–31 087). Table 5 shows that the highest density, *c*18 birds/km^2, was recorded in the semi-evergreen woodland of limestone escarpments and sheltered ravines (habitat

Plate 19. Juvenile Socotra Southern Grey Shrike *Lanius meridionalis*, Socotra, February 2011. © *RF Porter*

type A). Song has only been recorded in October and November, copulation on 24 February, nest building from 30 October, nests with eggs in November (c/4) and 18 February (c/2) and nests with young 14 November (c/2), adults feeding recently-fledged young have been observed 11 December–23 April, with most activity during February. Thus the known breeding season is October–April.

House Crow *Corvus splendens*. Hopefully the highly invasive House Crow has only a brief history in the annals of breeding birds on Socotra. Two adults, apparently with a nest with eggs or young, arrived on a boat from Aden in the mid 1990s. A small colony established in the palms near Hadiboh and reached a population of at least 15 individuals. This was successfully controlled and in 2009 the birds were finally eradicated (Suleiman & Taleb 2010). Fortunately the population did not spread to other areas of the island.

Brown-necked Raven *Corvus ruficollis* (Figure 12, Plate 20). In the archipelago this corvid only breeds on Socotra where it is widespread in a variety of habitats from 0–1050 m asl, but breeding was only proven in eleven (*c*27%) of the recording squares. For this species birds were counted on transects using a 200 m band width and many encounters were of birds flying overhead. The veracity of the calculations may thus be open to error but nevertheless show a population of 1511 individuals (95% CI 935–2441), which we believe to be a fair indication of the number on the island. Little information has been gathered on breeding biology but nests with eggs have been recorded 25 January–3 March with adults feeding two young in nest (age *c*10 days) on 27 February; adults also observed carrying food 22–28 November, indicating a breeding season November–March.

Plate 20. Brown-necked Raven *Corvus ruficollis* at nest, February 2011, Socotra. © *RF Porter*

Pale Crag Martin *Ptyonoprogne* (*fuligula*) *obsoleta* (Figure 13). This, the only martin that breeds on Socotra, is uncommon in the ravines and wadis of the Haggier mountains and their environs *c*200–600 m asl. Birds appeared to be resident in their breeding areas and none were seen away from these. The population was assessed by counting individual birds whenever a potential breeding area was visited and taking the highest count over the period 1999–2011: at ten sites a total of 60 birds was counted. Because it was not possible to visit all potential breeding areas in the difficult terrain of the Haggier mountains, it would not be unreasonable to assume that 60 birds represented less than half the population, which we would conservatively put at 50–100 pairs. Little data was gathered on breeding biology, but a pair was seen entering a nest on 22 February and aerial display in early March.

Black-crowned Sparrow-Lark *Eremopterix nigriceps* (Figure 14, Plate 21). This is the second commonest breeding bird, after the Socotra Sparrow and breeds widely on Socotra and Abd Al Kuri in open lowland habitats, often with scattered *Croton* on the main island; it rarely occurs above *c*200 m, though it has been recorded up to 520 m asl. On the main island it has been recorded in 35 squares (*c*87.5% of the island). Analysis of the transect data shows a population of 190 602 individuals (95% CI 126 270–287 720) on Socotra. Table 5 shows that the highest density, 114 birds/km^2, was recorded in the *Croton* shrubland on the coastal plains (habitat type D). Song and aerial display has been recorded November–March, copulation in December, nest building 15 November–28 February, nests with eggs (all c/2) 18 November–5 March, two nests with two young each to 27 February and newly fledged young in February, March and early April. Thus the known breeding season is November–March/April.

Plate 21. Black-crowned Sparrow-Lark *Eremopterix nigriceps*, Socotra, January 2006. © *Hanne & Jens Eriksen*

Socotra Cisticola *Cisticola haesitatus* (endemic, NT, Figure 15, Plate 22). Whilst the distribution map suggests a fairly widespread distribution on Socotra, this rather colonial species (pers obs) has rather specific habitat requirements and thus a fragmented distribution in each of the squares recorded. For this reason we did not employ the same methods used to determine the population of the other widespread passerines and near passerines which had less specific habitat requirements. Instead, through the breeding distribution surveys, we identified and measured the size of all *C. haesitatus* breeding areas and calculated the population in each using the same transect technique described above. The results are shown in Table 6.

As can be seen from Table 6 the Socotra Cisticola occurs in a variety of habitats and altitudes from coastal plains dominated by dwarf shrubland (Plate 23) to dwarf *Acacia edgeworthii* and to upland areas, notably the Ma'lih plateau at *c*650 m asl (Plate 24). In addition to the populations given in the table, this species was observed in very small numbers in a few isolated localities and thus it would not be unreasonable to assume a total Socotra population of 9000 individuals. This is similar to the population assessments of 3–4000

Plate 22. Socotra Cisticola *Cisticola haesitatus*, Socotra, January 2006. © *Hanne & Jens Eriksen*

Table 6. The breeding areas, habitats and populations of Socotra Cisticola *Cisticola haesitatus* on Socotra determined by surveys 1999–2008.

Locality (recording squares)	**Area (km²) of suitable habitat**	**Habitat**	**Population (individuals)**
Noged plain (Q7, R7, S7, T7, U7, V7 W6, W7, X6) 10 m asl	24.25	Open coastal plain with patches of dwarf shrubland dominated by *Indigofera*, *Limonium*, *Zygophyllum* and *Suaeda* and scattered trees in places	2150
Shu'ub, Neet and area (N5, N6, O6) 0 m asl	5.3	Dwarf shrubland dominated by *Zygophyllum*, *Limonium*, *Atriplex* and *Suaeda*.	1515
North coastal plain: airport to Di Selmeho/Ghubbah (R4, R5, S4, S5, T4) 5 m asl	30.15	Dwarf shrubland dominated by *Zygophyllum, Suaeda* and *Pulicaria.*	2510
Ma'alah plateau (O4) 650 m asl	20	Rich mosaic: mainly *Lycium* woodland with grasses and woody herbs, especially *Pulcaria*; some *Tamarix.*	1080
East of Hadiboh port (U4) 30 m asl	5.45	Dwarf *Acacia edgeworthii* shrubland	260
Interior plains (Q5, Q6, R6, S6) 30 m asl	14.5	Silty plain with *Pulicaria* shrub-steppe.	900
Momi plateau (Y5) 450 m asl	8	Limestone hills sparsely vegetated with grass and *Lycium* tussocks	220
Qariyah (W4) 5 m asl	0.5	*Zygophyllum* & *Croton* shrubland	40
Total	107.65		8675

Plate 23. Socotra Cisticola *Cisticola haesitatus* habitat at Shu'ub, Socotra, January 2007. © *Lisa Banfield*

Plate 24. Socotra Cisticola *Cisticola haesitatus* habitat, Ma'alah plateau, Socotra, February 2007. © *RF Porter*

pairs given by Stastny & Bejcek (2002) and Nadim Taleb (*in litt*), even though their surveys were less comprehensive. Song and display has been recorded 18 November–5 April (and probably into May), nest building 18 November–27 February, nests with eggs in February (c/3 & c/4), nests with young 31 October (surprisingly early)–28 February (with most in February) and recently-fledged young 12 December–23 April. Thus the known breeding season is mid October–late April. See also Stastny & Bejcek (2002).

Plate 25. Socotra Warbler *Cisticola incanus*, Socotra, November 2007. © *RF Porter*

Socotra Warbler *Cisticola incanus* (endemic, Figure 16, Plate 25). This, the second *Cisticola* species found on Socotra, is fairly widespread (36 squares—*c*90% of land area) in a variety of habitats with trees and shrubs from 0–1000 m asl. Analysis of the transect data shows a population of 26 685 individuals (95% CI 19 509–36 501). Table 5 shows that the highest density, *c*19 birds/km^2, was recorded in the submontane shrubland on the slopes and cliffs of the granite mountains (habitat type E). Song has been recorded November–April (and display-flighting, previously unrecorded, on 1 March 2011), nest building 20 November–1 March, nest with eggs in February (c/3), nests with young in February, but adults feeding fledged young 15 November–4 April. Thus the known breeding season is November–April.

Plate 26. Abyssinian White-eyes *Zosterops abyssinicus*, Socotra, February 2011. © *RF Porter*

Abyssinian White-eye *Zosterops abyssinicus* (Figure 17, Plate 26). Only found on Socotra in the archipelago. It is fairly widespread (over *c*75% of the main island), occurring anywhere with flowering trees and shrubs from 0–1000 m asl including town gardens, and may undertake local movements to follow the flowering periods of favoured plants. Analysis of the transect data shows a population of 27 567 individuals (95% CI 20 834–36 487). Table 5 shows that the highest density, *c*54 birds/km^2, was recorded in the semi-evergreen woodland of limestone escarpments and sheltered ravines (habitat type A). Song and display (including mutual preening in February) have been recorded 15 November–17 March, nest building late October–22 May, adults feeding fledged young and fledged young 23 November–2 March. Thus the known breeding season is late October–late May, one of the most extensive of the breeding birds on Socotra.

Somali Starling *Onychognathus blythii* (Figure 18, Plates 27, 28). This, the fourth commonest breeding bird is widespread and familiar throughout Socotra. It is found in a wide variety of habitats, including town gardens, with fruiting trees for feeding and cliffs with holes for nesting from 0–1050 m asl. Analysis of the transect data gave a population of 102 167 individuals on Socotra island (95% CI 66 434–157 120). Table 5 shows that the highest density, 114 birds/km^2, was in the semi-evergreen woodland of limestone escarpments and sheltered ravines (habitat type A). Nest building (carrying nesting material to holes in cliffs) has been recorded 15 November–18 February, egg shell remains were seen below nest holes on 23 November and adults recorded feeding recently fledged young 11 December–early April. Thus known breeding season is November–April. For further information see Gedeon & Neumann (2004). It also occurs on Abd Al Kuri and Samha.

Socotra Starling *Onychognathus frater* (endemic, Figure 19, Plate 29). This starling only occurs on the main island where it is most frequently encountered in the uplands

Plate 27. Male Somali Starling *Onychognathus blythii*, Socotra, October 2007. © *RF Porter*

Plate 28. Female Somali Starling *Onychognathus blythii*, Socotra, January 2006. © *Hanne & Jens Eriksen*

Plate 29. Socotra Starling *Onychognathus frater* feeding young, Socotra, February 2011. © *RF Porter*

200–1000 m asl. Analysis of the transect data shows a population of 25 187 individuals (95% CI 16 342–38 820). Table 5 shows that the highest density, *c*20 birds/km^2, was in the submontane shrubland on the slopes and cliffs of the granite mountains (habitat type E). Song has been recorded November–March, males displaying to females in February, nest building 15 November–12 December, adults incubating eggs or young 15–20 November and adults feeding young 1 December–4 April. Thus known breeding season is November–April. For further information see Gedeon & Neumann (2004).

Plate 30. Juvenile Socotra Sunbirds *Chalcomitra balfouri*, Socotra, October 2007. © *RF Porter*

Socotra Sunbird *Chalcomitra balfouri* (endemic, Figure 20, Plate 30). This, the sixth commonest breeding bird in the archipelago, is only found on Socotra where it is widespread, especially where trees, shrubs and nectar producing plants are in flower 0–1000 m asl. Analysis of the transect data shows a population of 65 876 individuals (95% CI 50 362–86 169). Table 5 shows that the highest density, *c*29 birds/km^2, was recorded in the semi-evergreen woodland of limestone escarpments and sheltered ravines (habitat type A). Song and display have been recorded 30 October–5 April, copulation 23 February, nest building 30 October–16 March, nests with eggs (2 × c/2) 1–3 March and nests with young 30 March (c/3)–1 May. Recently fledged (but still dependent) young have also been seen on 27 October (see Plate 30) and thus eggs would have been laid in about mid September. Thus the known breeding season is September–May.

Socotra Sparrow *Passer insularis* (endemic, Figure 21, Plate 31). This, the commonest breeding bird on Socotra is widespread in a variety of habitats with trees, including towns and villages, 0–1000 m asl. Analysis of the transect data shows a population of 328 992 individuals (95% CI 239 540–451 840) on Socotra. Table 5 shows that the highest density, *c*135 birds/km^2, was recorded in the open and woody-based herb communities on the limestone plateau (habitat type B). Song has been recorded 27 October–April, copulation in February and March, nest building 20 November–20 March and nests with young 23 November–June (when recently fledged young also seen, especially in February). Thus the known breeding season is November–June.

Abd Al Kuri Sparrow *Passer hemileucus* (endemic, VU, Figure 22, Plate 32). This sparrow has recently been split from *Passer insularis* (Kirwan 2008, Ryan *et al* 2010) and only occurs on Abd Al Kuri where ASS estimates the population to be *c*400 pairs, mostly in and around the villages.

Plate 31. Socotra Sparrow *Passer insularis*, Socotra, February 2011. © *RF Porter*

Plate 32. Abd Al Kuri Sparrow *Passer hemileucus*, Abd Al Kuri, April 2007. © *Peter Ryan*

Long-billed Pipit *Anthus similis* (Figure 23, Plate 33). This pipit only occurs on Socotra where it is the fifth commonest breeding bird and widespread in a variety of open habitats, often with trees, 0–1000 m asl. Analysis of the transect data shows a population of 94 528 individuals (95% CI 79 059–113 020). Table 5 shows that the highest density, *c*40 birds/km^2, was recorded in the open and woody-based herb communities on the limestone plateau (habitat type B). Song has been recorded 28 October–3 April, nest building and nests with eggs (2 × c/3) 17 November–4 March, nests (both with 2 young) on 18 November and 13 March, and recently fledged young November–23 April, with most seen in February. Thus known breeding season is November–April.

Plate 33. Long-billed Pipit *Anthus similis* dust-bathing, Socotra, October 2007. © *RF Porter*

Socotra Golden-winged Grosbeak *Rhynchostruthus socotranus* (endemic, Figure 24, Plate 34). Recently the golden-winged grosbeaks in Arabia and on Socotra have been split into two species (Kirwan & Grieve 2007). The Socotra Golden-winged Grosbeak is fairly widespread on Socotra (occurring over *c*70% of the island) in all areas with trees 0–1050 m asl, but with most in the altitude range 200–800 m. Analysis of the transect data shows a population of 16 802 individuals (95% CI 10 065–28 050). Table 5 shows that the highest densities, 15.5 birds/km^2, were in the submontane shrubland on the slopes and cliffs of the granite mountains (habitat type E) and the montane mosaic of shrubland and woodland and grassland in the granite mountains (habitat type F). Song has been recorded 30 October–16 March and recently-fledged young (being fed by adults) 21 December–16 March. Thus the known breeding season would appear to be October–March.

Plate 34. Socotra Golden-winged Grosbeak *Rhynchostruthus socotranus*, Socotra, October 2008. © *RF Porter*

Cinnamon-breasted Bunting *Emberiza tahapisi* (Figure 25, Plate 35). A widespread breeder in the higher elevations on Socotra, notably *c*500–800 m asl. Analysis of the transect data shows a population of 38 233 individuals (95% CI 25 097–58 246). Table 5 shows that the highest density, 30 birds/km^2, was recorded in the open and woody-based herb communities on the limestone plateau (habitat type B). Song has been recorded 13 November–17 March, copulation in November and December, nest building and nests with eggs (2 × c/3) 23 November–11 February and recently fledged young in February (adult with 3 young

Plate 35. Cinnamon-breasted Bunting *Emberiza tahapisi*, Socotra, April 2007. © *Peter Ryan*

on 27 February). Thus known breeding season appears to be November–March. Also recorded on Abd Al Kuri but breeding not proven.

Socotra Bunting *Emberiza socotrana* (endemic, VU, Figure 26, Plates 36, 37). This endemic bunting only breeds on the main island where it has been found breeding typically at *c*600 m asl. Analysis of the transect data shows a population of 3770 individuals (95% CI 1258–11 300), thus making it the rarest of the archipelago's endemic birds. Table 5 shows that the highest density, *c*12 birds/km^2, was in the submontane shrubland on the slopes and cliffs of the granite mountains (habitat type E, see Table 3). A small population was found on the limestone slopes at the extreme west of the island, and this may be more extensive than recorded due to the difficulty of access for surveying. The nest and eggs of this bunting are yet to

Plate 36. Socotra Buntings *Emberiza socotrana*, Socotra, October 2007. © *RF Porter*

Plate 37. Socotra Bunting *Emberiza socotrana*, Socotra, January 2006. © *Hanne & Jens Eriksen*

be described. Song recorded 20 November–29 February, adult incubating (nest contents unknown) in January, female with brood patch in February and recently fledged young (being fed by adults) 9–27 February. Thus the known breeding season would appear to be November–February, the shortest of any of the breeding birds on Socotra.

COMPARISON WITH ESTIMATES FROM 1993 SURVEYS

During the OSME survey of Socotra in March/April 1993 (Porter & Martins 1996) a total of 47.2 km of transects, recording all birds, was undertaken in a variety of habitats in the coastal plain (<100 m), foothills (100–400 m) and highlands (>450 m). These were used to determine the relative abundance and density (individuals/km^2) in the three altitudinal zones (Davidson 1996). Davidson's density value was calculated using the formula in Bibby *et al* (1992) and thus differed from ours as those calculations were based on a transect band width of 50 m and the formula included birds seen beyond this band width. Our more extensive transects systematically covered all altitudes and habitat types across the entire island and our calculations took into account the range and area of habitat each species occupied.

From Davidson's densities we calculated a total Socotra population for each species, estimating that the areas of coastal plain, foothills and highlands were roughly similar (*c*1230 km^2 each). We then compared with our population estimates and the data is presented in Table 7. Because of the paucity of data in Davidson (1996) and the fact that those observations were over a period of just one week and geographic coverage was limited, it would be dangerous to draw comparisons with ours. Certainly the data should not be used to draw any conclusions about population change. Our data supersedes that of Davidson (1996) and should be used to determine any future conservation actions or Red Listing assessments.

Table 7. Comparison of population estimates based on 1999–2008 transects with those made in 1993. This table only includes those species recorded on transects in 1993. Estimates rounded to nearest 50.

	Our estimate which surveyed 385.5 km of transects 1999–2008.	Estimate based on Davidson (1996) which surveyed 47.2 km of transects in March 1993
Laughing Dove	166 700	415 000
Bruce's Green Pigeon	7950	12 800
Socotra Southern Grey Shrike	26 000	109 000
Black-crowned Sparrow-Lark	190 600	99 800
Socotra Warbler	26 700	36 000
Abyssinian White-eye	27 550	17 400
Somali Starling	102 150	317 800
Socotra Starling	25 200	26 700
Socotra Sunbird	65 900	22 000
Socotra Sparrow	329 000	481 400
Long-billed Pipit	94 550	112 500
Socotra Golden-winged Grosbeak	16 800	3 500
Cinnamon-breasted Bunting	38 250	24 800

THREATS AND CONSERVATION

There have been no 'cause and effect' studies of the threats to birds on Socotra and thus all suppositions are based on personal knowledge of the systems concerned and a knowledge of specific actions on Socotra that are likely to impact bird populations. For passerines and near-passerines the main threats are considered to be from continuing over-grazing of grass, herbs and shrubs (Plate 38), the harvesting of live wood (Plate 39) and habitat fragmentation and destruction especially from road and building development (Plate 40). Looking to the future, large scale use of herbicides and pesticides could reduce seed and invertebrate food supplies. Intensification of agriculture, involving such factors, has been implicated in large declines of bird populations on farmland in western Europe in the latter part of the 20th century (Chamberlain *et al* 2000, Fuller 2000). The most immediate threats to the species covered in this paper are judged to be from building development on the coastal plains, which is likely to reduce the nesting area and habitats

Plate 38. Grazing goats on Socotra, November 2007. © *RF Porter*

Plate 39. Harvested live wood, Socotra 2007. © *RF Porter*

Plate 40. Unsympathetic road building, Socotra, October 2007. © *RF Porter*

of the near threatened Socotra Cisticola and rare (on Socotra) Nubian Nightjar, as well as Black-crowned Sparrow-Lark. In addition there is concern that road building across the limestone plateau in the west of Socotra could damage important breeding areas of the globally vulnerable Socotra Bunting (Miller *et al* 2007). The data gathered during this survey will be used extensively in reviewing and revising the Socotra IBAs catalogued in Evans (1994).

FUTURE SURVEYS

Although extensive, this survey at best provides provisional population estimates. In the future, techniques could be more refined and ideally any survey should be undertaken in one breeding season (say, over a two month period) by teams of observers covering the island comprehensively, though in reality this could be very difficult to achieve. Working more closely with botanists to ensure the correct identification of habitat types would be advantageous. Repeat samples of this survey (same periods, habitats, even transects) should also be considered for population monitoring. In this respect all raw data is available for study and interrogation and has been deposited with OSME, the Foundation for Endangered Wildlife (Yemen) and the Friends of Socotra.

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