Results of the first systematic boat-based seabird survey in Sri Lanka

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Sri Lanka has high avifaunal diversity but pelagic seabirds are the least studied group due to the constraints of conducting dedicated surveys at sea. Most early seabird records were from sightings at coastal viewpoints and the occasional stranding but, in the last few decades, some data have been collected opportunistically during boat-based cetacean surveys around Sri Lanka. This even resulted in the addition of new species to Sri Lanka's bird list, indicating that cetacean surveys could become important platforms of opportunity for seabird observation. In 2008 we initiated the first joint cetacean and seabird survey off south-western Sri Lanka, using compatible survey methodologies. The avifaunal results from this study are presented and discussed here. The benefits of the combined survey are also highlighted to show how such replicable surveys can become a useful model for seabird studies in developing countries where resources are limited.

INTRODUCTION

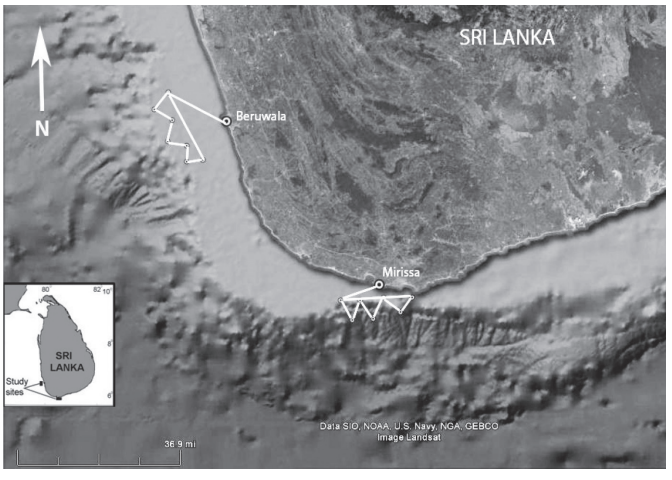
Sri Lanka is an island lying off the south-east coast of south India (5.916°–9.833°N 79.700°–81.883°E). Due to its tropical climate, varied vegetation and diverse habitats, the island is rich in avifauna, including endemic, resident and migrant birds. While research studies on the avifauna have been carried out on the island for well over a century (Warakagoda & Sirivardana 2011), pelagic seabirds have been the least studied group. This is primarily due to the financial and practical constraints of examining a group of birds that are often difficult to study through land-based surveys. Likewise, dedicated sea-based research cruises to study seabirds alone are a luxury too costly for a small developing country. Most records of seabirds were therefore sightings from coastal viewpoints and the occasional stranding (De Silva 1997), and several such early sightings were considered as vagrancies or stragglers due to a lack of knowledge of seabirds (Wijesinghe 1994).

Forty-nine species of seabirds have been recorded on Sri Lanka since 1880, of which ten are considered vagrants (Warakagoda *et al*. 2013). Seven are listed as regular or irregular breeders.

Another important group of little-studied fauna that abound in Sri Lanka's waters are the cetaceans, with some species known to be globally Endangered (Leatherwood & Reeves 1989, Ilangakoon 2006). Being a group of charismatic megafauna, funding for research on cetaceans is more readily available, hence dedicated vessel-based cetacean surveys have been carried out in Sri Lanka's waters over several decades (Alling 1986, Ilangakoon *et al.* 2000, Ilangakoon 2001, 2005, 2008, 2009), in the course of some of which opportunistic data on seabirds were also recorded (Ilangakoon 2001). Such observations even resulted in the addition of species not previously recorded in Sri Lankan waters (Karunaratne 1994, Ilangakoon 2001). These discoveries indicated that vessel-based cetacean surveys could become an important opportunity for pelagic seabird observations and data collection in countries such as Sri Lanka which lack the resources for dedicated seabird surveys.

In order to test the feasibility of carrying out simultaneous cetacean and seabird studies we initiated the first joint cetacean and seabird survey off south-western Sri Lanka in 2008–2009. The primary objective was to pool the available resources and maximise the benefits of data collection for both these important faunal groups, using compatible survey methodologies. Here we present the results of the avifaunal survey as a cost-effective method of undertaking seabird studies in developing countries.

Figure 1. Survey sites and transect lines.



METHODS

Two areas off the south-west coast of Sri Lanka with different depth profiles were selected for the study, which was carried out over a period of eight months from September 2008 to April 2009. The selected sites were off Beruwala (6.467°N 79.983°E) and Mirissa (5.967°N 80.483°E), two fishing ports about 170 km apart (Figure 1). One survey cruise per month was undertaken at each site, using an 11 m fishing vessel powered by inboard engines, travelling at an average cruising speed of 10–12 km per hour. A predetermined saw-tooth-shaped transect line, designed to maximise coverage of the selected areas, was repeated each month. The transect line off Beruwala straddled the 50 m depth contour, and the entire transect was within the continental shelf. In contrast, the transect line at Mirissa straddled the continental shelf break at 200 m and included areas of deep water beyond the shelf. Standard line-transect methodology (Tasker *et al.* 1984, Strindberg & Buckland 2004) was used to assess the relative abundance of species during different months in the two selected areas. Surveys were carried out in suitable weather conditions when the sea-state and visibility were good. If the sea-state deteriorated to above Beaufort 4 or heavy rain made visibility too poor, the survey was suspended until conditions improved or discontinued for the day, depending on the time of day.

Two dedicated seabird observers, equipped with binoculars, were on watch at all times during surveys, in addition to the cetacean observers onboard. All bird sightings were recorded as half-hour counts with the position, species, number, flock composition and activity on a standard data-sheet designed for the purpose. Basic environmental parameters such as weather and sea-state were also recorded and images and video footage were obtained when possible. The data thus obtained were tabulated and examined in terms of species composition, relative abundance and distribution in order to

determine patterns of occurrence and distribution and differences between sites and months.

RESULTS AND DISCUSSION

A total of 16 species of seabirds were observed during the study period from the two sites (Table 1), including 10 of the 16 members of the Sternidae family recorded in Sri Lanka. Five of the seven Sternidae species regularly or irregularly recorded breeding on Sri Lanka (Wijesinghe 1994) were encountered: Greater Crested Tern *Thalasseus bergii*, Roseate Tern *Sterna dougallii*, Common Tern *Sterna hirundo*, Little Tern *Sternula albifrons* and Bridled Tern *Onychoprion anaethetus* were the most common species noted during the surveys (Table 1). Other Sternidae encountered were Common Gull-billed *Gelochelidon nilotica*, Sooty *O. fuscatus*, Lesser Crested *T. bengalensis* and White-winged *C. leucopterus* Terns (Table 1). Four of the 12 Procellariiformes and two of the four Stercorariidae recorded for the country were also observed.

Bridled Tern was the most numerous species at both sites (Table 1), with sightings throughout the study period. This species was seen in both coastal and pelagic waters, but rarely more than 12 km from the coast or very close to the shore, indicating a definite corridor or flight path. Resting birds were often seen perched on floating debris. The largest numbers were recorded in September and October at both sites, while numbers were also slightly higher off Beruwala from January to March, and off Mirissa in March (Table 1). Bridled Terns are known to be the commonest pelagic seabird around Sri Lanka (Ilangakoon 2001). They have been observed breeding among nesting Common Terns on an islet in Adam's Bridge in the Gulf of Mannar, off the north-west coast (Perera 2003), and large numbers of both species were seen in flight over other islets that may also have been used for nesting. These observations confirm that Bridled Tern is a breeding resident, moving in search of food depending on ocean currents and upwellings (Harrison 1985, Robertson 1994). Using land-based observations, De Silva (2003) claimed a mass southward migration of this species, with numbers declining dramatically by November and no sightings thereafter. However, data from the current survey contradict this and show that significant numbers were present in coastal waters between November 2008 and April 2009. Sightings ranged from single individuals to over a hundred birds during half-hourly counts. Bridled Terns were also often encountered in mixed flocks with Common Terns and occasionally a few Whiskered and Little Terns. These mixed-species flocks were always encountered around visible sea-surface food sources such as baitfish, and sometimes associated with feeding dolphins.

Common Tern was the second most-recorded species: numbers increased in January at Beruwala and in February at Mirissa (Table 1). Common Tern sightings varied from single birds to groups of more than forty and were also often found in mixed-species flocks with Bridled and Whiskered Terns. The species can be described as a semi-pelagic tern, as birds were seen nearer to the shore than Bridled Tern, although in smaller numbers.

Whiskered Tern was most often encountered nearer to harbours or close to the shore, occasionally with Common and Bridled Terns. Sightings varied from a few individuals to a dozen out at sea. The species was not seen at either site in September but there was a steady increase from October, peaking in January at Beruwala and in February at Mirissa, after which a gradual decline in numbers was observed (Table 1). This could be due to flocking prior to dispersal to inland waters, as this species breeds at favoured inland sites.

Little Terns were absent from Beruwala during September and October and from Mirissa between September and November. Numbers were generally low except for a high count at Mirissa in February, with large flocks of 30–80 birds moving in a southerly direction (Table 1), perhaps paralleling the movement of Whiskered Terns, although Little Terns also breed on the coast.

Greater Crested Terns were present throughout, but numbers increased towards the latter part of the study (Table 1), probably due to the timing of the breeding season, from April to July (Warakagoda 1994), when they nest on coastal islets and rocky outcrops. They were observed close to shore as well as further out at sea, and occasionally perched on floating debris.

Only a single Lesser Crested Tern was seen in the first three months of the survey. Numbers at Mirissa increased from December to a maximum of 24 in February, but declined in March and April; this species is known to be a winter visitor to Sri Lanka (Rasmussen & Anderton 2012).

One of the biggest surprises during the survey was the sighting of a single White-faced Storm Petrel *Pelagodroma marina*, the first confirmed sighting for Sri Lanka (Hettige 2008), although Robertson (1994) and Lamsfuss (2000) mentioned that this species might occur during the south-west monsoon.

Swinhoe's Storm Petrel *Hydrobates monorhis* was recorded in relatively large numbers during the study, particularly in September and October, when they were seen moving north (Table 1). This was in contrast to earlier reports which considered the species to be a

Table 1. Species and numbers of seabirds observed each month during surveys at the two study sites, Beruwala (B) and Mirissa (M), September 2008 to April 2009.

Month	September		October		November		December		January		February		March		April	
Date	16	18	6	8	11	13	13	15	3	5	11	7	16	12	1	3
Site	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M
Bridled Tern *Onychoprion anaethetus*	371	584	299	279	11	171	27	20	179	27	76	10	292	130	39	77
Common Tern *Sterna hirundo*	0	1	5	21	5	17	70	51	247	48	58	355	15	40	6	33
Whiskered Tern *Chlidonias hybrida*	0	0	0	1	24	0	85	24	245	59	4	293	63	67	9	4
Little Tern *Sternula albifrons*	0	0	0	0	9	0	3	38	4	8	9	124	1	9	9	8
Greater Crested Tern *Thalasseus bergii*	1	2	11	8	1	0	5	5	6	3	0	0	25	0	53	44
Lesser Crested Tern *Thalasseus bengalensis*	1	0	0	0	0	0	1	1	0	0	0	24	1	13	3	8
Common Gull-billed Tern *Gelochelidon nilotica*	0	0	2	0	0	0	0	1	1	0	0	1	0	13	0	0
Roseate Tern *Sterna dougallii*	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Sooty Tern *Onychoprion fuscatus*	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
White-winged Tern *Chlidonias leucopterus*	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0	0
Swinhoe's Storm Petrel *Hydrobates monorhis*	0	11	3	2	0	0	0	0	0	0	0	0	0	0	0	0
Wilson's Storm Petrel *Oceanites oceanicus*	0	6	10	5	0	0	0	0	0	0	0	0	0	0	0	0
White-faced Storm Petrel *Pelagodroma marina*	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Bulweria sp.	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
South Polar Skua *Catharacta maccormicki*	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Pomarine Skua *Stercorarius pomarinus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

summer straggler to Sri Lankan coastal waters (Warakagoda 1994, Wijesinghe 1994). Opportunistic observations by the authors of 93 Swinhoe's Storm Petrels off Mirissa during two days in October 2009 suggest that the species is a more common migrant in Sri Lanka than previously thought. Onley & Schofield (2007) mention that it migrates westward from breeding grounds in Japan to the northern Indian Ocean, although the precise route was unknown. More recent work in the Singapore Strait suggests that this is a key migratory route (Poole *et al*. 2014). The recording of substantial numbers in this part of the Indian Ocean during the present study is the first indication that Sri Lanka lies on the species's migration route and sheds more light on its movements.

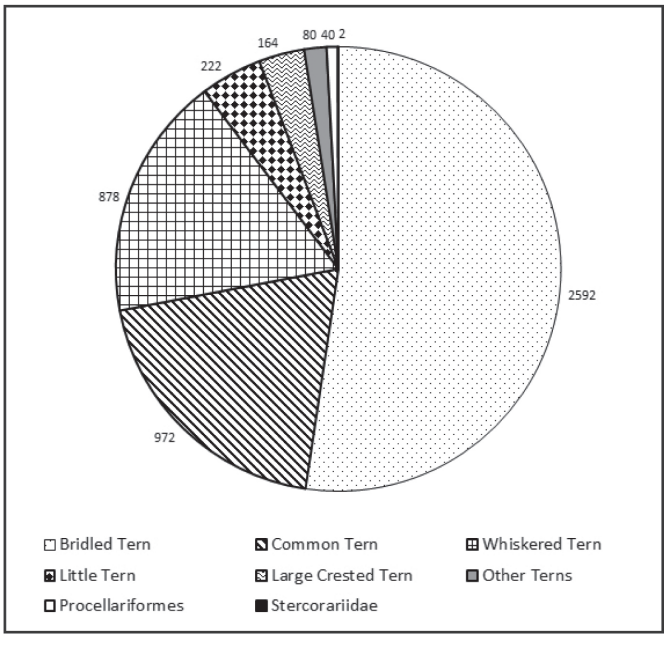
A total of 21 Wilson's Storm Petrels *Oceanites oceanicus* was recorded (Table 1). This species is known to visit Sri Lankan waters; earlier work off the west coast found much higher numbers during the south-west monsoon between May and September (Warakagoda 1994, Ilangakoon 2001).

Other Procellariiformes recorded in the present study included distant views of two individual *Bulweria* petrels in September and October, not identified to species level. However, both Jouanin's Petrel *Bulweria fallax* and Bulwer's Petrel *B. bulwerii* have previously been recorded off Sri Lanka (Karunaratne 1994, Ilangakoon 2001). The study period was largely outside the south-west monsoon, which draws to an end in September, when the diversity (De Silva 1997) and numbers of interesting pelagic species are found to be high (Ilangakoon 2001).

Two Stercorariidae were recorded—a single South Polar Skua *Catharacta maccormicki* at Beruwala in November and a single Pomarine Skua *Stercorarius pomarinus* at Mirissa in April.

Full details of the species recorded, numbers seen and dates of surveys are given in Table 1 and Figure 2. The highest number of species recorded in a month was seven at both sites—Beruwala in October and Mirissa in all months except November and January. The total number of birds observed peaked in January at Beruwala and February at Mirissa (Figure 2). Mirissa had higher species richness during the survey period, with 15 species recorded, while Beruwala had 11. Mirissa also had a slightly higher overall count of 2,658 birds, compared with 2,292 from Beruwala. The reason for the differences may be due to both the continental shelf and deeper pelagic waters being covered at Mirissa. However, the differences are quite small and the survey was carried out over only one year, so it is not possible to draw any firm conclusions.

Figure 2. Species diversity and relative abundance.



CONCLUSION

Despite not covering the south-west monsoon period (May–September), our survey added a new species to the list of seabirds recorded for Sri Lanka, increasing the total to 49 (Warakagoda *et al*. 2013). Opportunistic observations during the south-west monsoon on earlier cetacean surveys and tourism-related seabird trips have added several species to the Sri Lankan list (Ilangakoon 2001, Pepper & Hettige 2008), indicating higher pelagic bird diversity during the south-west monsoon. All accepted records of new species during the last decade have been recorded either during pelagic birdwatching trips (Pepper & Hettige 2008) or opportunistically during cetacean surveys (Karunaratne 1994, Ilangakoon 2001); four new species have thus been added to the Sri Lankan avifauna. We therefore conclude that joint seabird and cetacean surveys are both useful and feasible, as seen from the success of the present study. However, we suggest that future surveys should include the south-west monsoon period, although sea conditions would probably be less than ideal, as this period is important for seabirds and cetaceans, including some of the more unusual cetacean species in Sri Lanka's waters (Ilangakoon 2008).

This survey, the first joint seabird and cetacean survey undertaken off Sri Lanka, has shown without doubt that surveys of this nature can maximise benefits for researchers of both faunal groups, and may be a cost-effective model for developing countries. As methodologies can be standardised for both faunal groups, maximum benefit may be derived from scarce resources. Therefore, we conclude that this methodology can be replicated in other areas and even include other marine faunal groups which may be used as indicator species to determine the health of the oceans.

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