

Marine surveys to study the movements of seabirds through the Singapore Strait 2010–2013

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Until October 2010 there had been little concerted work and nothing published on the movements of seabirds through the sea area known as the Singapore Strait, which lies between the Strait of Malacca to the west and the South China Sea to the east. This paper details the results of regular monthly surveys in the period from October 2010 to November 2011 and eight follow-up surveys in 2012 and 2013. These surveys confirmed that the Singapore Strait is a key passage area for Aleutian Tern *Onychoprion aleuticus* and the Near Threatened Swinhoe's Storm-petrel *Hydrobates monorhis*—with over 500 of the latter being recorded in a few hours on a single day on 17 September 2011. Pomarine Skua *Stercorarius pomarinus* and Long-tailed Skua *S. longicaudus* were recorded on several occasions, Short-tailed Shearwater *Ardenna tenuirostris* on spring passage, and significant numbers of Bridled Terns *O. anaethetus* in autumn. The skuas, Red-footed Booby *Sula sula* and Short-tailed Shearwater had not previously been recorded in the area. Based on the data gathered, the Singapore Strait is a marine migratory bottleneck as defined by BirdLife International and should qualify as an Important Bird Area.

INTRODUCTION

The Singapore Strait (hereafter the Strait) is the 105 km long, 16 km wide area of sea between the Strait of Malacca in the west and the South China Sea in the east. Singapore is on the north of the channel and the Indonesian Riau archipelago on the south. It is one of the busiest commercial shipping lanes in the world.

Until the 1980s observations of seabirds in these waters were largely incidental. They were mainly odd records of Swinhoe's Storm-petrels *Hydrobates monorhis* observed or collected from ships or the Horsburgh Lighthouse, Singapore (1.330°N 104.407°E)—specimens are now held in the Raffles Museum of Biodiversity Research (Wells 1999, Wang & Hails 2007, Lim 2009). In the 1980s and 1990s Richard Ollington and others, including SR, began using ferries operating between Singapore and the Indonesian Riau archipelago to collect data on passing seabirds (Ollington & Loh 1996a), and on 13 October 1996 a vessel was specifically chartered for such a survey. It was in this period that Swinhoe's Storm-petrel was first found to pass through the area in significant numbers (Lim 1989, Ollington 1993, Rajathurai 1996), and Aleutian Tern *Onychoprion aleuticus* was first recorded as a passage and winter visitor (Kennerley & Ollington 1998). However, by the late 1990s interest in seabirds had waned and there was no further focused effort to observe birds at sea until October 2010.

On 2 October 2010 CMP, GWHD, SR and a group of Singapore resident birdwatchers chartered a sport-fishing boat and travelled east along the Strait between Singapore and Batam island, Riau Archipelago, Indonesia (Figure 1), searching primarily for Swinhoe's Storm-petrel (Foley 2011, Poole *et al.* 2011). The success of this charter generated such interest that monthly surveys continued for the next year with funding from the Singapore

National Parks Board as part of the government's Comprehensive Marine Biodiversity Survey of Singapore, and have continued subsequently by the same group and others, some with the support of Nature Society (Singapore).

METHODS

The surveys were carried out using a chartered 30-ft sport-fishing boat; the boat normally left the marina on the south-east tip of Sentosa Island at about 06h00, clearing Singapore immigration just west of the Sisters' Islands (1.213°N 103.830°E), and surveys began between 07h00 and 07h30 (first light 06h45–07h00). The surveys followed the same route, first crossing the main shipping lane at the Strait's narrowest point south of St John's Island and heading east, north of Batam island on the southern edge of the shipping lane to a yellow buoy off the north coast of Batam (1.217°N 103.995°E) about 19 km to the east. From that point the route changed depending on birds and weather, but usually headed north and east towards Pengerang, Johor, Malaysia, and then returned along the northern side of the shipping lane to Sisters' Islands immigration point, checking buoys along the way for roosting terns (Figure 1).

Sea conditions were usually calm with good light and visibility, and observations were made from the open stern or upper deck of the boat by 10 observers. When possible, interesting sightings were pursued and photographic records obtained. Chumming was tried on three occasions but without noticeable success and was discontinued. Once the surveys funded by the Singaporean National Parks Board had been completed in November 2011, follow-up trips observed the same timetable and route. The only



Figure 1. Map of Singapore Strait showing the usual survey route.

exceptions were one exploratory trip to the west in March 2012 and three trips to Horsburgh Lighthouse (also known as Pedra Blanca), a small rock island marking Singapore's most easterly territory (1.330°N 104.408°E) on 20 August 2011, 16 June 2012 and 28 July 2013; these three visits were primarily focused on assessing the status of nesting terns.

The route taken travelled through Singaporean, Indonesian and Malaysian waters. GPS data were recorded for all sightings, but due to the confusion over exact territorial limits for bird recording purposes in the area, and the fact that many of the sightings were potentially recorded in all three countries, no specific attempt has been made here to locate records to specific geographical level.

RESULTS

The results of 22 surveys carried out between 2 October 2010 and 15 September 2013 are shown in the Appendix.

*Swinhoe's Storm-petrel *Hydrobates monorhis**

Strong eastward spring passage in May and westward autumn passage in September recorded, particularly the latter. The maximum numbers recorded were 96 passing east on 5 May 2012 and 510 passing west on 17 September 2011. Two birds on 18 June 2011 may have been very late passage migrants or possibly over-summering birds. The latest autumn record was of two on 13 November 2010 (Tan Kok Hui pers. comm.). Birds usually exhibited strong migratory behaviour, flying low over the sea, quickly and determinedly, so that the boat could not keep pace with them. However, occasionally they were found on the water resting or feeding, often in pairs, and sometimes allowed close approach (Foley 2011, Poole *et al.* 2011). Autumn passage was much stronger and over a longer period (September to November) than spring passage (May). All birds seen at close range in the autumn period appeared to be adult, the plumage often heavily worn, although none was seen in active moult. In contrast birds seen in May, and specimens collected in May examined by CMP in the Raffles Museum of Biodiversity Research, Singapore, were all fresh, confirming that they moult in the Indian Ocean during the winter (Flood & Fisher 2011).

The species is a passage migrant through the Strait between its north-east Asian breeding grounds and Indian Ocean non-breeding grounds (Flood & Fisher 2011, BirdLife International 2014). First recorded from the Strait in May 1913 (Wells 1999), birds have since been recorded in spring and autumn, usually from ferry trips between Singapore and Indonesia (Lim 1989, Ollington & Loh 1996a). Highest previous counts were more than 100 between Batam, Bintan and Singapore on 28 September 1991 (Rajathurai 1996), an estimate of '1,000 birds per hour' observed from the Batam Island to Singapore ferry on 5 September 1993 (Ollington 1993), 360+ from the ferry between Bintan Island and Singapore on 3 October 1996 (SR pers. obs.) and 138 recorded from a boat charter to Horsburgh Lighthouse on 13 October 1996 (SR pers. obs.). The 1993 estimate was based on an extrapolation of the number of birds seen passing the ferry across a 3 km wide part of the Strait; unfortunately the observer does not state how many birds were actually counted (Ollington 1993).

Wells (1999) states:

The migrant stream has not been followed out of Singapore waters but must turn south as only one autumn bird has been recorded in the Melaka Straits: collected at One-Fathom Bank lighthouse, latitude 2°51'2" N, on 7 November 1918. Sightings at the NW entrance of the Java Sea accord and birds have been seen and collected on appropriate dates in the Sunda Straits, which is perhaps this population's route to the Indian Ocean...

It would seem unlikely that having passed west through the Strait birds then turned back south-south-west along the east coast of Sumatra and through the islands of the Riau archipelago to reach the Sunda Strait. Instead we consider it far more likely that all the birds we saw continued north up the Malacca Strait to the Indian Ocean. Recent spring and autumn records from exploratory marine surveys off the west coast of Peninsular Malaysia from Parit Jawar in Johor, Port Dickson in Negri Sembilan and Tanjung Dawai in Kedah (Bird i-witness 2014), as well as an additional historical record further north (Lewin 1960), add weight to the theory that birds migrate through the Strait and then continue north through the Malacca Strait into the Indian Ocean.

It is not clear why the numbers of birds recorded in the Strait are much higher in autumn than spring, or why as yet only worn adults have been recorded in the autumn passages. Perhaps birds of different ages use different routes at different times? There are no winter records from the Strait, despite historical specimen records in December and January from Borneo and Java (Wells 1999, Mann 2008).

BirdLife International (2014a) estimates a global population of 260,000 mature individuals, and recently revised the species's conservation status to Near Threatened on the basis that the population is expected to undergo a moderately rapid decline over the next three generations, owing primarily to the impact of introduced species (rodents and plants) on the breeding grounds in Russia, Japan and South Korea.

*Short-tailed Shearwater *Ardenna tenuirostris**

Small eastward spring passage with eight on 14 May 2011 seen well enough to identify to species; not recorded in autumn. Several other records of 'small dark shearwater sp.' similarly moving east in early/mid May 2012 and May 2013 were assumed to be this species. Not previously recorded from the Strait (Wells 1999, Wang & Hails 2007, Lim 2009), also apparently not previously recorded from Indonesian waters (N. Brickle pers. comm.). These records match the timing of recent sightings from the west coast of Peninsular Malaysia and Thailand (Wells 1999, Bakewell & Tan 2010) and Hong Kong (Welch & Yu 2010). However, *contra* to what is suggested by Bakewell & Tan (2010), the timing and direction of the Singapore Strait records suggest that some birds are moving from the Indian Ocean south-west through the Malacca Strait into the South China Sea via the Singapore Strait before travelling north past Hong Kong and into the Pacific.

A possible record of a bird photographed on a flooded field at Woodlands, Singapore, after a storm in June 1998 (Lim 2009) was in fact, based on a copy of the photograph, a Wedge-tailed Shearwater *A. pacifica* (Wang & Hails 2007, Wells 2007 and pers. comm., CMP pers. obs.).

*Lesser Frigatebird *Fregata ariel**

Two immature birds were recorded en route to and at Horsburgh Lighthouse on 20 August 2011. There are a few previous records from Singapore, including Horsburgh Lighthouse (Wang & Hails 2007, Lim 2009), however, it is known to roost in numbers on Rengis, an island off Pulau Tioman, Pahang, Malaysia, only 170 km to the north (Wells 1999).

*Christmas Island Frigatebird *Fregata andrewsi**

One immature flew east through the Strait on 4 May 2013 and photographs and video footage were obtained (<http://ibc.lynxeds.com/video/christmas-frigatebird-fregata-andrewsi/immaturefemale-flying-alongside-boat-fish-bill>). There are very few earlier records from the Strait (Wells 1999, Wang & Hails 2007, Lim 2009). The species is Critically Endangered with a global population of 2,400–4,800 mature individuals (BirdLife International 2014b) and breeding is confined to Christmas Island over 1,300 km to the south of Singapore. However, a regular non-

breeding population of over 200 birds has recently been documented from Jakarta Bay, Indonesia, 870 km to the south-east (Noni 2012), and satellite-tracking data show that significant numbers of birds move north through the Sunda Strait between Java and Sumatra and into the Java Sea. It is also recorded from the Pahang–Johor archipelago where Wells (1999) states ‘they roost together with the more numerous Lesser Frigatebirds on Rengis’; therefore its occurrence in the Strait should be expected.

Red-footed Booby *Sula sula*

An immature at the east end of the Strait close to Malaysia on 13 May 2012 was photographed by Francis Yap. Not previously recorded from the Strait (Wells 1999, Wang & Hails 2007, Lim 2009); there is a record from the Riau archipelago to the south in August 1984 (Rajathurai 1996, Wells 1999), and a recent record of a bird photographed perched in a tree in north-west Singapore in February 2011 (Chan *et al.* 2013). The nearest currently documented breeding colonies are on Christmas Island over 1,300 km to the south, and in the Flores and Banda Seas, Indonesia, over 1,900 km to the south-east (de Jong 2011, N. Brickle pers. comm.).

Aleutian Tern *Onychoprion aleuticus*

Recorded regularly between August and November, numbers peaked annually in mid-September with maximum counts of at least 20 on 17 September 2011, 24 on 15 September 2012 and at least 30 moving west on 15 September 2013. At least one, possibly three, in the western Strait on 12 March 2012 may have been on early return passage. Two immature (first-summer and second-summer) birds recorded on 20 August 2011 suggest overwintering by young birds in the area. Birds were regularly found resting on flotsam, but were never seen using the buoys favoured by the larger terns.

First recorded in the Strait in September 1994 (Kennerley & Ollington 1998), the main wintering areas are little known, but are believed to be coastal throughout Indonesia (Hill & Bishop 1999, Goldstein *et al.* 2014). It is surprising that the species was not recorded in the winter months, especially as the wintering site at Tanjong Balai, Pulau Karimun, Indonesia, documented in the 1990s by Kennerley & Ollington (1998) is only 50 km to the south-west across the Strait. However, Ollington & Loh (1996b) also only recorded it in the Strait on passage and not in winter, so it may be that the wintering range off Pulau Karimun is very restricted for some reason. For logistical reasons this specific area was not visited during surveys and the status of birds at this site should be followed up as a priority.

This species breeds in the north Pacific Ocean on the coasts of Sakhalin and Kamchatka, Russia, on the Bering and Pacific coasts of Alaska and on the Aleutian Islands, USA (BirdLife International 2014c), with a previously estimated global population of 30,000–35,000 individuals (Delany & Scott 2006). However, recent work in Alaska indicates that the species is in steep decline, with an estimated 95% decrease over the past three generations and a current estimated Alaskan population of just 4,000–7,000 breeding individuals (Renner *et al.* 2014).

Bridled Tern *Onychoprion anaethetus*

Previously confirmed breeding at Horsburgh Lighthouse between 2003 and 2008 with a maximum of over 200 individuals estimated to be present (Yong D. L. *in litt.*) and as a significant eastward passage migrant through the Strait in autumn with ‘Daily totalsabove 300 through September,...’ (Wells 1999). Recorded on passage in small numbers westward in May and large numbers eastward from August to November, peaking in September, with a maximum of 609 moving east on 17 September 2011, compared to only 40 west on 13 May 2012. Not recorded during the winter or early spring. About 100, including recently fledged juveniles, recorded around Horsburgh Lighthouse on 20 August 2011 and similar numbers, again including juveniles, on 28 July 2013.

Little Tern *Sternula albifrons*

A common breeding resident in Singapore (Wang & Hails 2007, Lim 2009). Recorded in small numbers, usually closer to shore, between March and November. Wells (1999) mentions a post-breeding passage from August to at least early December and a spring passage from late February to early May. However, on 10 March 2012 over 150 birds were recorded flying east in the western Strait; these were presumably not part of a local population.

White-winged Tern *Chlidonias leucopterus*

An uncommon passage migrant and winter visitor to Singapore, with numbers declining recently (Wang & Hails 2007, Lim 2009). Recorded early in spring and late in autumn with a maximum of 81 on 19 March 2011.

Black-naped Tern *Sterna sumatrana*

Recorded in small numbers, usually closer inshore between March and November. Eight birds (adults and immatures) perched on rocks in suitable breeding habitat at Horsburgh Lighthouse on 20 August 2011 and 18 there on 16 June 2012, indicate they may breed there. Also regularly recorded close to the rocks of Pulau Anak Sambu on the very northern tip of Batam in the summer months, indicating it may also breed there, and five pairs recorded around small islands in the western Strait on 10 March 2012. An uncommon resident in Singapore, with only one recent documented breeding locality in the north-east at Loyang (Wang & Hails 2007, Lim 2009). Recorded between 2003 and 2008 as a non-breeding visitor to Horsburgh Lighthouse, with 200–300 birds counted but no summer records and no confirmation of breeding (Yong D. L. *in litt.*).

Common Tern *Sterna hirundo*

An uncommon passage migrant and winter visitor to Singapore (Wang & Hails 2007, Lim 2009). This species was recorded in small numbers, maximum four birds, in spring and autumn, with summer-plumage adults of both *tibetana* and *longipennis* subspecies noted (based on bill colour). Seen resting on and foraging around flotsam along with Aleutian Tern (see above).

Lesser Crested Tern *Thalasseus bengalensis*

Recorded throughout the year, except in July and August, with a maximum of 47 on 19 November 2011; often found roosting on large buoys with Greater Crested Terns *T. bergii*—probably under-recorded as distant terns were unidentified due to possible confusion with the latter species. Fifteen birds in non-breeding plumage were in the Strait on 14 May 2011, one on 18 June 2011 and a further six with large numbers of Greater Crested Terns at Horsburgh Lighthouse on 16 June 2012, indicating the regular presence of overwintering (first-year?) birds in the area. Although known to be a common winter visitor to Singapore, these records may represent some of the largest numbers recorded in the area and the first recent midsummer records (Wang & Hails 2007, Lim 2009).

Greater Crested Tern *Thalasseus bergii*

Known as a common winter visitor to Singapore, with few previous midsummer records (Wang & Hails 2007, Lim 2009). Recorded throughout the year, except in April and May. Often found roosting in mixed flocks on large buoys (see above). The maximum number recorded in the Strait was 44 on 15 October 2011 with an indication of eastward passage in autumn. On 16 June 2012, 108 in non-breeding plumage, and showing no sign of nesting behaviour, were counted at Horsburgh Lighthouse. However, a juvenile-plumaged bird actively food-begging from adults on a buoy close to the Singapore shore off Bedok on 19 November 2011 may indicate that some birds breed closer than the current nearest known breeding colonies, on Layang-Layang in the South China Sea 1,300 km to the north-east (Poole 1994), or in coastal Myanmar (Wells 1999).

Long-tailed Skua *Stercorarius longicaudus*

One immature on 2 October 2010, one non-breeding adult on 20 August 2011, and another non-breeding adult moving west with migrating Bridled Terns on 13 May 2012, all photographed. Dates and behaviour indicate the species is perhaps a passage migrant (Wells 1999, Wang & Hails 2007, Lim 2009); this is the commonest of the three skua species recorded in recent years off the north-west coast of Peninsular Malaysia (D. Bakewell pers. comm.).

Arctic Skua *Stercorarius parasiticus*

One immature on 15 January 2011 (Foley 2011, Poole *et al.* 2011), one immature 16 April 2011 and two immatures on 15 October 2011 were all photographed in the same eastern area of the Strait between north-east Batam, Changi and Johor. Two subsequently seen and photographed by Francis Yap and others from the Nature Society (Singapore) on 20 December 2011 between Batam and Changi appear from comparison of photographs to be the same two immature birds we saw in the same area two months previously (CMP pers. obs.), indicating possible overwintering in the area. There is only one previous published record from Singapore, off the north-west coast in September 1988 (Wells 1999, Lim 2009).

Pomarine Skua *Stercorarius pomarinus*

One immature on 13 November 2010 and another on 19 March 2011 (Foley 2011 & Poole *et al.* 2011) were harassing terns in the east of the Strait between Batam, Indonesia, Changi, Singapore and Johor, Malaysia. Not previously recorded from the Strait (Wells 1999, Wang & Hails 2007, Lim 2009).

DISCUSSION

These surveys have confirmed that the Strait is a key passage area for migrating Swinhoe's Storm-petrel—with over 500 being recorded in a few hours on 17 September 2011 and 470 on 15 September 2012—and Aleutian Tern, which is commoner in the Strait than Common Tern, in contrast to areas further north in Peninsular Malaysia (Wells 1999). In addition there were summer records of Swinhoe's Storm-petrel and Aleutian Tern, indicating possible oversummering of both species. Pomarine, Arctic and Long-tailed Skua were all recorded on several occasions during passage and in winter, none of which had previously been photographed in the Strait. Short-tailed Shearwater, similarly previously unrecorded in the Strait, was confirmed on spring passage, and significant numbers of Bridled Terns were documented moving east in spring and west in autumn. In addition Red-footed Booby was recorded for the first time in the Strait. These surveys have greatly increased our knowledge of the status of pelagic birds in the Strait and, as highlighted by Poole *et al.* (2011), have shown how much is still to be understood about seabirds in South-East Asia and what could be learned by similar efforts in other areas.

Based on the data gathered on the numbers of the Near Threatened Swinhoe's Storm-petrel passing through the Strait during these surveys the area qualifies as an Important Bird Area (IBA) under Category A4 ii and iv Congregations (BirdLife International 2010). It is particularly important as it captures one of the four major parts of a seabird lifecycle, qualifying under the BirdLife International (2010) marine IBA definition of a migratory bottleneck: 'sites whose geographic position means that seabirds fly over or round in the course of regular migration. These sites are normally determined by topographic features, such as headlands and straits.'

The majority of the birds observed during the surveys appeared to favour the centre or south side of the Strait, with few birds observed close to the Singapore side particularly among the high shipping use and ship mooring areas. This potentially fits with the

findings of Schwemmer *et al.* (2011), who in a study of the impact of commercial shipping on loons (*Gavia* sp.) and sea-ducks in Europe found that birds 'showed strong behavioral responses and, possibly more importantly, altered distribution pattern in response to ship traffic'. If this were the case, continuing port development in northern Batam could potentially make the southern part of the Singapore Strait less favourable to seabirds in the future, restricting passage to an even narrower corridor.

According to the US Energy Information Administration (2012) over 60,000 vessels transit the Strait of Malacca annually and they identified the area as 'the key chokepoint in Asia' for oil transportation, stating 'at its narrowest point in the Phillips Channel of the Singapore Strait, Malacca is only 1.7 miles wide creating a natural bottleneck, as well as potential for collisions, grounding, or oil spills'. In early 2014 three small spill incidents were reported in the space of two weeks (Environment News Service 2014). The threat of any pollution incident in this mid-channel area where most of the birds are moving, particularly in the months of May and August–October, could have a severe impact on certain migratory seabird populations, especially so for potentially significant percentages of the global population of Swinhoe's Storm-petrel and Aleutian Tern.

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Appendix.

Birds seen on 22 surveys carried out between 2 October 2010 and 15 September 2013 in the Singapore Strait.

	2/10/2010	13/11/2010	18/12/2010	15/1/2011	19/2/2011	19/3/2011	15/4/2011	14/5/2011	18/6/2011	16/7/2011	20/8/2011	17/9/2011	15/10/2011	19/11/2011	10/3/2012	5/5/2012	13/5/2012	16/6/2012	15/9/2012	4/5/2013	28/7/2013	15/9/2013	
Swinhoe's Storm-petrel <i>Hydrobates monorhis</i>	20							25	2			510	7			96	4		470	18			96
Short-tailed Shearwater /small dark shearwater sp. <i>Ardenna tenuirostris/ Ardenna</i> sp.								8								4	5				1		
Lesser Frigatebird <i>Fregata ariel</i>											2												
Christmas Island Frigatebird <i>Fregata andrewsi</i>																					1		
Red-footed Booby <i>Sula sula</i>																	1						
Aleutian Tern <i>Onychoprion aleuticus</i>	8										2	20	9		1+				24				30+
Bridled Tern <i>Onychoprion anaethetus</i>		7						4			268	609	73			2	40	50+	296	13	100+	270	
Little Tern <i>Sternula albigifrons</i>	1	6					4		3	4	1		1	8	150	2	1	2		2	1		
White-winged Tern <i>Chlidonias leucopterus</i>						81	54							10						5			
Black-naped Tern <i>Sterna sumatrana</i>	*	1				2	5	18	3		8				13	8	2	18		3			
Common Tern <i>Sterna hirundo</i>		1									2	4							2		2		
Lesser Crested Tern <i>Thalasseus bengalensis</i>	*	9	2	20	9	24		15	1			1	6	47	10		8	6	1	14			
Greater Crested Tern <i>Thalasseus bergii</i>	*	5	16	21	32	4				4	9	10	44	9	11	30		108	22	2	5		
'Crested' Tern sp. <i>Thalasseus</i> sp.		43	13	5	29	13	2							21	6					4			
Long-tailed Skua <i>Stercorarius longicaudus</i>	1										1						1						
Arctic Skua <i>Stercorarius parasiticus</i>				1			1						2										
Pomarine Skua <i>Stercorarius pomarinus</i>		1				1																	

* recorded but not counted