

Movements of Lesser Crested *Thalasseus bengalensis* and Bridled Terns *Onychoprion anaethetus* bred in the Arabian gulf, based on ringing recoveries

BRENDAN KAVANAGH, JEM BABINGTON & NICOLE PROVEN

This paper presents information, based especially on ringing recoveries, on the movements of two Sterninae species that breed in mixed tern colonies in the Arabian gulf (hereafter 'Gulf'), the Lesser Crested Tern *Thalasseus bengalensis* and Bridled Tern *Onychoprion anaethetus*. The subspecies of Lesser Crested Tern in the Gulf is thought to be *T. b. emigratus* that also breeds in Libya, with scattered irregular breeding in southern Europe. Most *emigratus* are thought to winter off the northwest and west African coasts (Gochfeld *et al* 2016a). Lesser Crested Terns breed during May and June in the Gulf and normally lay a single egg incubated for 21–30 days. When birds hatch they are led from the nest at two–four days and fed away from the nesting area. From seven days old, chicks are gathered into crèches of mixed-age young, protected by adults. Fledging takes 30–35 days, with many birds able to fly by the end of July. Parents look after the young for a further five months (Gochfeld *et al* 2016a). Birds are thought to be able to breed at two years old (Gochfeld *et al* 2016a).

The subspecies of Bridled Tern in the Gulf is *O. a. antarcticus*. It also occurs in the Red sea and Indian subcontinent south to the Seychelles, Aldabra, Madagascar, Mascarenes and Maldives (Gochfeld *et al* 2016b). Bridled Terns arrive in the Gulf in March and stay until late October with breeding occurring May/June–August. Egg laying has been recorded in the Gulf 24 April–mid July with most May and June (Jennings 2010). A single egg is laid that is incubated for 28–30 days with juveniles fledging 50–65 days later with dependent young remaining around the colony for a further 30–35 days (Gochfeld *et al* 2016b). Juvenile birds may visit the breeding colony late in the breeding season at three years old, but first breeding is thought not to occur until birds are four years old (Gochfeld *et al* 2016b).

Lesser Crested and Bridled Terns disperse from the Gulf for the winter, although these movements are poorly known. Data on Lesser Crested Tern movements from the Middle East are scarce but birds have previously been thought to winter south along the east coast of Africa to Natal (Gochfeld & Burger 1996), and northern parts of the Indian Ocean, including southern Arabia, and the south-west Pacific (Jennings 2010). A heavy southward movement of Bridled Terns peaking in August and September has been noted off the Kalpitiya peninsula and past Colombo, Sri Lanka, involving up to 250 000 birds (Gochfeld *et al* 2016b). Bridled Tern is regularly seen in small numbers in the south and northwest of Sri Lanka November–April and in May birds can be seen coming within a kilometre of the shore near Trincomalee as well as over the beach on the Kalpitiya peninsula and Chilaw sand spit (de Silva Wijeyeratne 2010). The origin of these Bridled Terns is unknown. Both tern species are thought to overwinter at sea after abandoning their breeding grounds (Gochfeld & Burger 1996, Jennings 2010). Two papers have previously been published on ringing recoveries of Lesser Crested and Bridled Terns from the Gulf (Kasambe & Deshmukh 2011, Tayefeh *et al* 2012).

We have been conducting a ringing study on these two tern species in Bahrain since 2007 and these data, combined with data from Saudi Arabia (Abdullah Al Suhaibani pers comm) plus published data from Iran (Kasambe & Deshmukh 2011, Tayefeh *et al* 2012),

have been analysed by us to help understand movement patterns and dispersal of these two Gulf breeding species.

STUDY AREAS

In Bahrain, terns breed mainly on the Al Jarrim islands (Figure 1), three islands locally named Al Jarrim North, South and Middle. These islands are c20 km north of Manama city. The North island is a natural island and the Middle and South islands are manmade (created over 20 years ago from dredging spoil). All three islands are several metres above high tide and have well-vegetated central areas interspersed with bare areas (Plate 1) making them ideal for both Lesser Crested (Plate 2) and Bridled Terns (Plates 3–5). It is estimated that the islands hold 6 000 and 300 pairs respectively; accounting for c50% of Bahrain’s total breeding populations of these species (Kavanagh 2010).

In eastern Saudi Arabia, terns nest on five main Gulf coral islands that were formed from sand that built up on submerged coral reefs and broke through the water surface. These islands are Karan (Figure 1), Jana, Juraid, Kurain and Harqus, located 35–90 km offshore from Jubail industrial city. All of the islands have grown in size over time but have elevations of less than three metres above the high tide line and are aligned along the edge of an area where the Gulf increases in depth to 35 m. All are vegetated primarily with *Suaeda vermiculata* and *Salsola baryosma* bushes that are quite dense in places, reaching one metre high and located mainly in the centre of the islands. The offshore islands in the northern Gulf in Saudi Arabia are known to be of international importance for breeding terns, particularly for Lesser Crested and Bridled Terns while Greater Crested *Thalasseus bergii* and White-cheeked Terns *Sterna repressa* occur in numbers of regional



Figure 1. Location of the Bahrain, Saudi Arabia and Iran ringling sites in the Arabian gulf 1991–2014.



Plate 1. Al Jarrim South island, Bahrain, where ringing of breeding Lesser Crested Tern *Thalasseus bengalensis* and Bridled Tern *Onychoprion anaethetus* chicks occurred 2007–2014, photo 20 June 2014. © Jem Babbington



Plate 2. (left) Lesser Crested Tern *Thalasseus bengalensis* Al Jarrim South island, Bahrain, 20 June 2014. © Jem Babbington

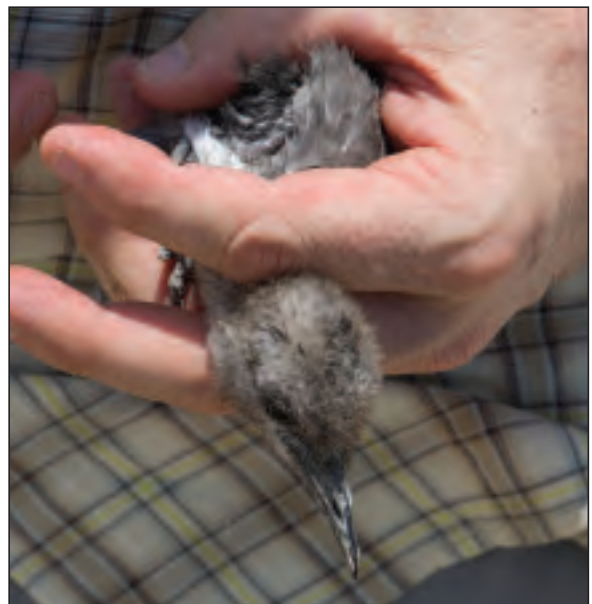


Plate 3. (right) Bridled Tern chick *Onychoprion anaethetus* being ringed Al Jarrim South island, Bahrain, 20 June 2014. © Jem Babbington

importance. These colonies of Lesser Crested Terns are the largest and densest in the world and represent a significant proportion of the total world population of this species whilst the large breeding populations of Bridled Tern place the islands among the five most important breeding areas for this species in the world (Symens & Evans 1993). Lesser Crested Terns nest on open bare ground on these islands which have a combined population of c28 000 pairs whereas Bridled Terns nest under low vegetation and have a combined population of c35 000 pairs.

In Iran, the Lesser Crested Tern breeds on several islands off the Gulf coast including Banifaror (Bani Farour), Gabre Nakhoda (Ghabr-e Nakhoda), Nakhilo (Figure 1), Khan and Sheedvar islands (Tayefeh *et al* 2013, Behrouzi-Rad 2014), and has bred previously on Farsi,



Plate 4. (left) Bridled Tern *Onychoprion anaethetus* Al Jarrim South island, Bahrain, 20 June 2014. © Jem Babbington

Plate 5. (right) Bridled Tern *Onychoprion anaethetus* Al Jarrim South island, Bahrain, 20 June 2014, metal ring on right leg. © Jem Babbington

Booneh and Kharkuo, which could not be surveyed in recent times for security reasons. This species has recently disappeared from Dara island off the northern Iranian gulf coast and Omol-Karam (Om-Al-Gorm) island off the middle Iranian gulf coast due to predation and disturbance (Tayefeh *et al* 2011). The combined breeding population of Lesser Crested Terns on all these Iranian islands was 16 010 pairs in 1970 and increased to 29 927 pairs in 2009 with 28 677 pairs in 2012 (Tayefeh *et al* 2013). The Bridled Tern breeds on Banifaror, Um-Al-Gorm, Nakhilo, Dara, Sheedvar, Gabre Nakhoda and Bone (Behrouzi-Rad 2014). The combined breeding population of Bridled Terns on these Iranian islands was 25 300 pairs in 1970 and increased to 66 015 pairs in 2009 and 68 534 pairs in 2012 (Tayefeh *et al* 2013, Behrouzi-Rad 2014).

The shallow waters of the Gulf combined with high temperatures and sunlight support a rich food supply for tern chicks thus contributing to the increase in populations in recent decades (Loughland & Zainal 2009).

METHODS

Ringling of both tern species was conducted in Bahrain 2007–present. Ringling occurred predominantly on the Al Jarrim islands (Figure 1) with minor numbers ringed at two other island sites nearer to Manama city. Metal rings from the British Trust for Ornithology ringling scheme were used with ringling conducted one or two days per season (June, July) when most birds had hatched and formed crèches but had not fledged. A total of 6864 terns were ringed during the period, 5421 Lesser Crested Terns and 1443 Bridled Terns. Ringling was carried out privately by a team of ringers which included the authors of this paper.

Ringling was conducted under license in Saudi Arabia 1991–1994 and again in 1997, when a total of over 45 000 birds were ringed with metal rings issued by the Saudi Wildlife Authority. Most of these birds were Lesser Crested Terns but included smaller numbers of Bridled Terns and White-cheeked Terns and a very small number of Greater Crested Terns. Most ringling was on Karan island, with additional ringling on Kurain, Jana and Juraid. Saudi Wildlife Authority rings were used on these islands (Figure 1).

Ringling in Iran was conducted on the four Mond islands: Omol-Karam, Nakhilu (Figure 1), Khan and Tahmadon that are located in the northern part of the Gulf in southeastern Bushehr province. Khan island is in the Mond protected area and the rest are in Nakhilu marine national park. From 2003–2010, chicks of tern species were marked with metal rings on Omol-Karam and Nakhilu by personnel from both the Bushehr provincial office and the wildlife bureau of the Iranian department of the environment (DOE). A total of 5897 terns were ringed during the period including 4836 Lesser Crested Terns and 628 Bridled Terns (Tayefah *et al* 2012).

RESULTS AND DISCUSSION

Ringling and recovery data for 14 Lesser Crested and three Bridled Terns from Bahrain, Saudi Arabia and Iran are shown in Tables 1–3. Figure 1 shows the location of the ringling sites in Bahrain, Iran and Saudi Arabia. Figure 2 maps the recovery and movement data of Bridled and Lesser Crested Terns, 1991–2014. A Lesser Crested Tern ringed as a young chick 22 June 2012 on Al Jarrim South, Bahrain, was found at Gholvad, Maharashtra, 2376 km away from the breeding colony 80 days later on 10 September 2012 (Q in Figure 2 and Tables 1–3) and a Lesser Crested Tern chick ringed on Nakhilu, Iran, in summer 2006 (K in Figure 2 and Tables 1–3) was recovered on the west coast of India in November 2006, both suggesting the species moves east-south-east from the Gulf towards the coast of India immediately after leaving the breeding area. The remaining Lesser Crested Tern recoveries in India (F, J, L, P and V in Tables 1–3), both young and adult birds, were distributed south along the Maharashtra coast and were recovered between November and January. Birds

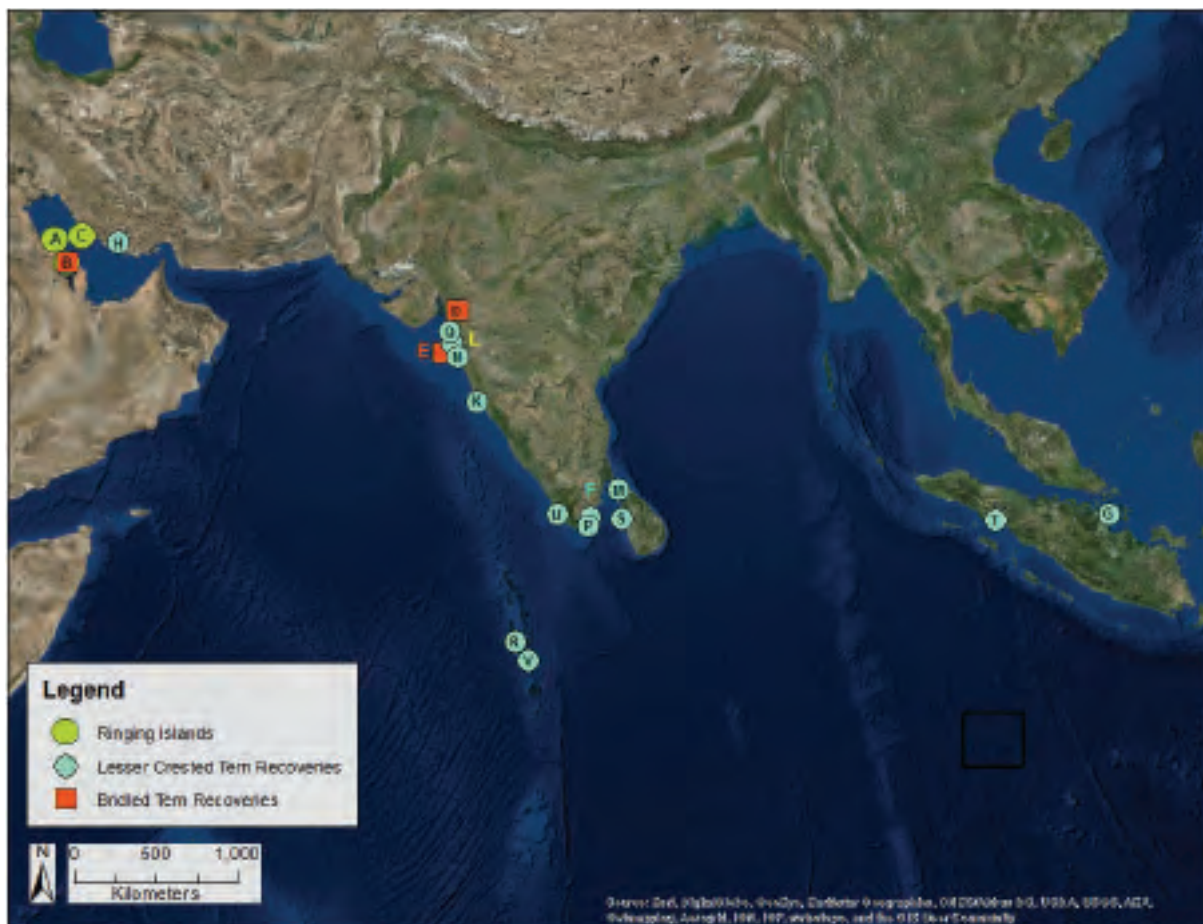


Figure 2. Ringling, recovery and movement data of Bridled and Lesser Crested Terns ringed in the Arabian Gulf from 1991–2014. Letter A is location of the breeding sites in Saudi Arabia, letter B: Bahrain and letter C: Iran. All letters correspond to those in Tables 1–3.

Table 1. Ringing data of Bridled *Onychoprion anaethetus* and Lesser Crested Terns *Thalasseus bengalensis* ringed in Bahrain, Saudi Arabia and Iran, in the Arabian gulf, 1991–2014 and which were subsequently recovered. Letters in the left hand column correspond with those in Figure 2 and Tables 2 and 3. (K, L and N after Kasambe & Deshmukh 2011, H, J, K and P after Tayefeh *et al* 2012).

	Species	Ring number	Ringing date	Ringing location (islands)	Country	Coordinates
D	Bridled Tern	E001886	1993 or 1994	Karan	Saudi Arabia	27°43'N 49°49'E
E	Bridled Tern	SR57248	17 Jul 2008	Al Jarrim Middle	Bahrain	26°24'N 50°29'E
B	Bridled Tern	SR58087	17 Jul 2008	Al Jarrim South	Bahrain	26°23'N 50°28'E
F	Lesser Crested Tern	E002675	28 Jun 1992	Karan	Saudi Arabia	27°43'N 49°49'E
G	Lesser Crested Tern	E00524*	1992	Karan (probably?)	Saudi Arabia	27°43'N 49°49'E
H	Lesser Crested Tern	DH1152	03 Aug 2004	Nakhilu	Iran	27°49'N 51°28'E
J	Lesser Crested Tern	EE1612	15 Jul 2005	Nakhilu	Iran	27°49'N 51°28'E
K	Lesser Crested Tern	DH2377	16 Jul 2006	Nakhilu	Iran	27°49'N 51°28'E
L	Lesser Crested Tern	DD08696	27 Jun 2008	Al Jarrim South	Bahrain	26°23'N 50°28'E
M	Lesser Crested Tern	DE12827	19/06/2009	Al Jarrim South	Bahrain	26°23'N 50°28'E
P	Lesser Crested Tern	DW05357	30 Aug 2010	Nakhilu	Iran	27°49'N 51°28'E
Q	Lesser Crested Tern	DE64753	22 Jun 2012	Al Jarrim South	Bahrain	26°23'N 50°28'E
R	Lesser Crested Tern	DE64793	22 Jun 2012	Al Jarrim South	Bahrain	26°23'N 50°28'E
S	Lesser Crested Tern	DE64207	13 Jul 2012	Al Jarrim South	Bahrain	26°23'N 50°28'E
T	Lesser Crested Tern	DT02051	20 Jun 2014	Al Jarrim South	Bahrain	26°23'N 50°28'E
U	Lesser Crested Tern	DE65264	22 Jun 2012	Al Jarrim South	Bahrain	26°23'N 50°28'E
V	Lesser Crested Tern	DE64942	13 Jul 2012	Al Jarrim South	Bahrain	26°23'N 50°28'E

from the Gulf probably winter in the area (Kasambe & Deshmukh 2011). Additional Lesser Crested Terns were recovered further south in Tamil Nadu (F), Maldives (L), Sri Lanka (I) and Indonesia (M). A bird seen in Malaysia with a metal ring was photographed two km off the west coast at 3°14' N, 101°16' E on 16 November 2013 and was presumably from the Gulf as these are the only known ringing projects in the entire region. Other records of recovered birds include two Lesser Crested Terns from Saudi Arabia recovered in India 2002 (F in Tables 1–3) and Indonesia in 2010 (G in Tables 1–3). Apart from one recovery (H) in the Gulf several years later, there were no recoveries of Lesser Crested Terns elsewhere.

There were two recoveries of Bridled Tern from the Bahrain project where the ring number was fully read. One (B in Figure 2 and Tables 1–3) was found dead on the breeding islands. The other (E in Figure 2 and Tables 1–3) was found in west India, at Kelve, Thane district, Maharashtra state. In addition, a third Bridled Tern (D in Figure 2 and Tables 1–3), ringed in Karan, Saudi Arabia, was recovered close to Surat in Gujarat state, which is 200 km further south of the location from which the Bahrain bird was reported. Both Indian recoveries were of different aged birds, one a juvenile ringed 17 July 2008 on Al Jarrim South (Bahrain) being found at Kelve, 2357 km away, 62 days later on 17 September 2008. The other bird was an adult that was found at the same time of year having been ringed in 1993 or 1994 on Karan and found near Gabheni, Surat 7 September 2011. This adult bird was at least 17 years old.

Our data, supported by published ringing recovery records, would indicate that Lesser Crested and Bridled Terns nesting in the Gulf spend the non-breeding season in the Indian

Table 2. Recovery data of Bridled *Onychoprion anaethetus* and Lesser Crested Terns *Thalasseus bengalensis* ringed in the Arabian gulf 1991–2014. Letters in the left hand column correspond with those in Figure 2 and Tables 1 and 3.

	Species	Ring number	Recovery date	Recovery location	Country	Co-ordinates
D	Bridled Tern	E001886	07 Sep 2011	Gabheni, Surat, Gujarat	India	21°08'N 72°82'E
E	Bridled Tern	SR57248	17 Sep 2008	Kelve, Thane District, Maharashtra	India	19°02'N 72°04'E
B	Bridled Tern	SR58087	22 Jun 2012	Al Jarrim Middle island	Bahrain	26°24'N 50°29'E
F	Lesser Crested Tern	E002675	11 Dec 1992	Kayalpatnam, Tamil Nadu	India	08°34'N 78°10'E
G	Lesser Crested Tern	E00524	25 Jan 2010	Cemara, Jambi	Indo-nesia	00°00'N 103°49'E
H	Lesser Crested Tern	DH1152	07 Jul 2009	Shidvar island, Hormozgan	Iran	26°79'N 53°41'E
J	Lesser Crested Tern	EE1612	27 Aug 2009	Kanyakumari, Tamil Nadu	India	08°08'N 77°55'E
K	Lesser Crested Tern	DH2377	12 Nov 2010	Sindhudurg, Maharashtra	India	16°02'N 73°27'E
L	Lesser Crested Tern	DD08696	31 Dec 2009	Aranal Beach, Virar, Maharashtra	India	19°27'N 72°44'E
M	Lesser Crested Tern	DE12827	24 May 2011	Jaffna	Sri Lanka	09°40'N 80°00'E
P	Lesser Crested Tern	DW05357	10 Aug 2011	Kanyakumari, Tamil Nadu	India	08°08'N 77°55'E
Q	Lesser Crested Tern	DE64753	10 Sep 2012	Gholvad, Maharashtra	India	20°05'N 72°43'E
R	Lesser Crested Tern	DE64793	10 Jan 2013	Nilandhoo, Faafu Atol	Maldives	03°03'N 72°53'E
S	Lesser Crested Tern	DE64207	27 Dec 2012	Barus, Sumatra	Indo-nesia	02°00'N 98°23'E
T	Lesser Crested Tern	DT02051	20 Oct 2014	Atol	Maldives	01°56'N 73°23'E
U	Lesser Crested Tern	DE65264	18 Nov 2015	Puttalam lagoon	Sri Lanka	08°05'N 79°45'E
V	Lesser Crested Tern	DE64942	29 Nov 2015	Valiazheekal, Kerala	India	09°07'N 76°27'E

ocean, moving along the west Indian coast, south to southern India, Sri Lanka and the Maldives (Kasambe & Deshmukh 2011, Tayefeh *et al* 2012), with some birds moving further east as far as Indonesia and peninsular Malaysia. This is at odds with the conventional belief expressed by Gochfeld & Burger (1996), supported by Jennings (2010) and most recently restated by del Hoyo & Collar (2014), that the races of both Lesser Crested and Bridled Terns breeding in the Gulf winter off the west African coast and northern parts of the Indian ocean. The recovery of 11 Lesser Crested Terns indicates that the population in the Gulf travels as far east as peninsular Malaysia shortly after leaving the breeding grounds with birds recovered as early as August in Tamil Nadu, south India, and in December and January in the Maldives and Indonesia. The two Bridled Terns recovered on the other hand were both from the northwest Indian coast in September. Considering that over 50 000 Lesser Crested and less than 3000 Bridled Terns have been ringed in the Gulf region, the absence of recoveries of the latter species is no surprise. The elucidation of the winter movements of the Bridled Terns will require more ringing effort in the region. It is of note that there have been no recoveries of Gulf ringed terns along the east African coast or Madagascar suggesting that their movement is ESE once they vacate the Gulf region.

Ring numbers of 57 Lesser Crested Terns on the Mond islands off Iran were read through a telescope or photographed (Tayefeh *et al* 2012). In addition, one Lesser Crested Tern with a metal ring from Bahrain was photographed breeding at a colony off Kuwait (Jennings 2010) showing evidence of movement between breeding colonies in the northern Gulf region. This display of site fidelity and between-site movement supports the notion

Table 3. Movement data of Bridled *Onychoprion anaethetus* and Lesser Crested Terns *Thalasseus bengalensis* ringed in the Arabian gulf 1991–2014. Duration is the calculated number of days between ringing and recovery. Distance is the linear distance between ringing and recovery locations in km. Direction is the calculated compass direction from ringing to recovery in degrees.

	Species	Ring number	Duration	Distance	Direction
D	Bridled Tern	E001886	6266 days	2430 km	106° (ESE)
E	Bridled Tern	SR57248	62 days	2357 km	111° (ESE)
B	Bridled Tern	SR58087	1436 days	2 km	45° (NE)
F	Lesser Crested Tern	E002675	169 days	3306 km	121 (ESE)
G	Lesser Crested Tern	E00524	6418 days	6615 km	120° (ESE)
H	Lesser Crested Tern	DH1152	1800 days	230 km	135° (SE)
J	Lesser Crested Tern	EE1612	1504 days	4100 km	134° (SE)
K	Lesser Crested Tern	DH2377	1610 days	2599 km	116° (ESE)
L	Lesser Crested Tern	DD08696	552 days	2404 km	109° (ESE)
M	Lesser Crested Tern	DE12827	704 days	3620 km	121 (ESE)
P	Lesser Crested Tern	DW05357	346 days	4101 km	134° (SE)
Q	Lesser Crested Tern	DE64753	80 days	2376 km	108° (ESE)
R	Lesser Crested Tern	DE64793	202 days	3526 km	138° (SE)
S	Lesser Crested Tern	DE64207	167 days	5790 km	118° (ESE)
T	Lesser Crested Tern	DT02051	122 days	3657 km	138° (SE)
U	Lesser Crested Tern	DE65264	1244 days	3699 km	124° (SE)
V	Lesser Crested Tern	DE64942	1234 days	3342 km	126° (SE)

that the populations in the Gulf are interconnected which is likely to lead to increased breeding success as well as providing a better knowledge of food resources and refuges against predators (Coulson 2002).

Bridled Terns showed site fidelity during this study with a pair ringed on Karan island in Saudi Arabia breeding in exactly the same place in following years (Abdullah Al Suhaibani pers comm). Additional supplementary evidence was provided by a Bridled Tern ringed as a chick on Al Jarrim island South 17 July 2008 that was found dead as an adult on Al Jarrim island Middle 22 June 2012 after 1436 days suggesting this bird had returned to the islands to breed. Another Bridled Tern adult was photographed on Al Jarrim South 20 June 2014 with a metal ring on its leg (Plate 4) that was ringed as a chick on the same island although the full ring number could not be read.

Our ringing data support the fact that Lesser Crested and Bridled Terns are faithful to the Gulf for breeding either doing so on the island where they were born or other close-by islands in the same area. It is also evident that both species vacate their breeding grounds soon after fledging and move in an east-south-east direction toward northwest India with young of both species ringed as chicks in Bahrain reaching northwest India by early September of the same year. This is further supported by a Lesser Crested Tern from Karan island in Saudi Arabia doing likewise.

Our data are evidence that some Lesser Crested Terns at least, then spread out further towards southern India, the Maldives and Sri Lanka and others move on even further

east-south-east towards Indonesia and Malaysia where a tern ringed with a metal ring presumably in the Gulf, was seen off the west coast at 3°14' N, 101°16' E on 16 November 2013.

Bridled Tern data suggests birds may spend the winter in the area around the Indian coast. While Bridled Terns were found across the entire range from the sea coast of India to c90 km offshore throughout the year, these birds were thought by Karuthedathui *et al* (2012) to be residents from the breeding colonies from Pittie island in Lakshadweep (in the Arabian sea, 420 km west of Kerala). The ringing data presented here confirms that at least some of the Bridled Terns found offshore along the west Indian continent come from the Gulf breeding areas.

The total number of recoveries is still small and over time a clearer picture will be revealed but the data reported here gives a good indication of both species movements after breeding in the Gulf. Continued ringing of these species in the Gulf region will add considerably to our understanding of the movement patterns of these graceful terns.

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Brendan Kavanagh, Royal College of Surgeons in Ireland, 123 St Stephens Green, Dublin 2, Ireland. bkavanagh@rcsi.ie
Jem Babbington & Nicole Proven, c/o Saudi Aramco, PO Box 13007, Dhahran 31311, Saudi Arabia. jembabbington@btinternet.com