



# Breeding population of Terns and Western Reef Heron *Egretta gularis* on Ghabre Nakhoda and Dara Islands, in Persian Gulf in 2003, 2009, 2012 and 2016

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## Abstract

The research was conducted on Ghabre Nakhoda and Dara islands in Khore Mosa Creek in Persian Gulf on August in 2003, 2009, 2012, and 2016. Total count method was used to obtain the census of the nests and breeding population of terns and Western Reef Heron on Islands. Five species of terns and Western Reef Heron had bred on Ghabre Nakhoda and Dara islands in 2003, 2009, 2012, and 2016. Average breeding pairs of Lesser Crested Tern *Thalasseus bengalensis*, Swift Tern *Thalasseus bergii*, Bridled Tern *Sterna anaethetus*, White-cheeked Tern *Sterna repressa*, Caspian Tern *Hydroprogne caspia* and Western Reef Heron *Egretta gularis* were 1368, 63, 217, 71, and 13 pairs on Ghabre Nakhoda and 127, 7, 54, 4, 9, and 6 pairs on Dara, respectively. Thirty-one species from ten families belonged to two order of water birds recorded on August in 2003, 2009, 2012, and 2016 on both islands. Total number of counted water birds was 26303 individuals on Ghabre Nakhoda and 17404 individuals on Dara Island in 2003, 2009, 2012 and 2016. Maximum species richness on Ghabre Nakhoda was in 2016(31 species), but on Dara island was in 2009(18 species).

**Keywords:** Breeding population; Terns; Western Reef Heron; Khore Mosa; Persian Gulf; Iran

## Introduction

The detailed knowledge of general seabird ecology and of the numbers and productivity of many populations makes them particularly appropriate as a choice of bio-monitor or bio-indicator [1,2]. The colonial nature of breeding seabirds has several benefits. It allows numbers to be tracked for less effort than if the breeding populations were dispersed, and it allows large quantities of data to be collected from a particular site in a relatively short period of time. However, to be useful, a bio-monitor must respond in a sensitive way to changes in the variable for which it is a proxy measure [1,2]. It is widely accepted that the number of water birds using a site is a good indicator of that site's biological importance, and they are also important indicator of the ecological condition of their habitats [3]. Terns are colonial breeding in Persian Gulf islands [4-7], and are bio-indicators to monitor the status of the environment of Islands [8]. There are 34 islands on northern part of Persian Gulf belong to Iran, six of them located in Khore Mosa in Khuzestan province

[7]. Ghabre Nakhoda located in Middle of Khore Mosa and Dara at mouth of Khore Mosa (Figure 1).

The creeks and islands in the Khore Mosa are suitable sites for fishing and harvesting of shrimps and other aquatic species [7]. Terns, Herons, Gulls and Waders form important animal group heavily dependent on the islands for their continued existence [9]. There are many species of these seabirds in the Persian Gulf, [10,11] but the Ghabre Nakhoda and Dara Islands is important breeding site for terns, three in particular nest in vast number on the islands, these are the Lesser Crested Tern *Thalasseus bengalensis*, Swift Tern *Thalasseus bergii* and Birdled Tern *Sterna anaethetus*. These three species of terns are dominant breeding in most islands of Persian Gulf [5,6] Herons notably Western Reef Heron *Egretta gularis* Little Egret *Egretta garzetta* and some wader species especially Crab Plover *Dromas ardeola* breed on this island [5,7,9,11,12]. Although the islands still support substantial water

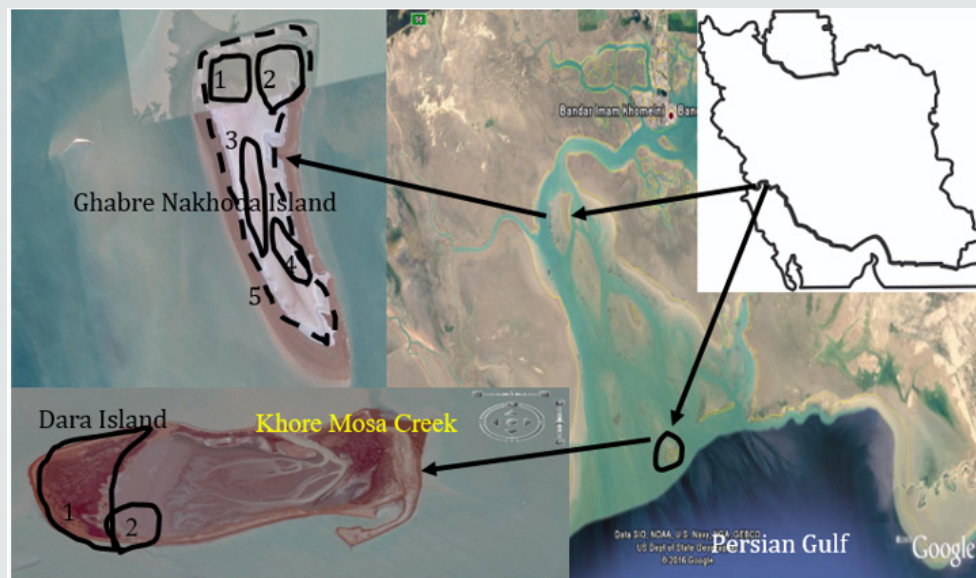
bird foraging and nesting populations, recent surveys suggest that population size has been reduced from historic levels. On the other hand, one of the aims of monitoring is to provide information for ecological assessment, which can provide early warning of changes that could negatively affect species or ecosystems [8]. For these reasons and protecting the sensitive habitats of water birds in Persian Gulf, also to awareness of breeding population changes for protecting the sensitive habitats, present study was carried out to count and compare the present population of colonial breeding tern's species on Ghabre Nakhoda and Dara islands in Khore Mosa Creek in Persian Gulf in the breeding season.

## Methods and Materials

### Study Area

Khore Mosa Creek ( $30^{\circ}11'01''N49^{\circ}01'56''E$ ) is consisted of several estuaries, creeks, and a main canal and is an important

place for fisheries and aquaculture activities. All creeks around it are most important intertidal habitats of the Persian Gulf shoreline. There are a lot of small islands in Khore Mosa, but two of them (Ghabre Nakhoda and Dara) are important habitats for water birds (Figures 1 & 2). These islands are flat, sandy and Shelly, 70-90% of area of the Ghabre Nakhoda Island covered by vegetation in Feb and March, but More than two third of Dara island surface covered by water by a small branch of creek. All around of the islands are sandy beach (Figures 1 & 2). Area of the Ghabre Nakhoda Island is 3 hectares in high tide and more than 800 hectares in ebbs. There is a Grave in the middle of island, named Ghabre Nakhoda (Ghabr mean is Grave and Nakhoda meaning is Captain). Area of the Dara Island is 160 ha. Main plant species of both islands are *Atriplex leucoclada*, *Stipa capensis*, *Suaeda fruticosa*, *Halostachys belangeriana*, *Calanderula persica*, *Malva sp*, and *Cistanche tubolosa*. *Cistanche tubolosa* is vulnerable specie, *Calendula persica* is an endemic species [5,6,8].



**Figure 1:** Nests locations of breeding species on Ghabre Nakhoda and Dara Islands in 2003,2009,2012 and 2016. On Ghabre Nakhoda Island ( $30^{\circ}20'46''N48^{\circ}55'30''E$ ): 1-Caspian Tern, 2-Lesser Crested and Swift Terns 3-White Cheeked Tern 4-Western Reef Heron 5-Bridled Tern and On Dara Island ( $30^{\circ}06'06''N 49^{\circ}06'06''E$ ): 1- Western Reef Heron, Bridled and Caspian Terns 2- White Cheeked Tern.



**Figure 2.**

## Data Collection

The nests of terns and Western Reef Heron were counted directly on Ghabre Nakhoda and Dara Islands on August 2003, 2009, 2012 and 2016. The nests of Lesser Crested, White Cheeked, Caspian, and Swift terns (on sandy place of islands without any vegetation) and Western Reef Heron (on short bushes) were counted easily, because they were visible, (Figure 2). The nests of Bridled Tern were under the short bushes and were counted by looking under the bushes. Observation was done on August 15<sup>th</sup>, every year, which all breeding species had made nests and finished egg-laying. All birds observed and counted on mudflat of around of both islands, Ghabre Nakhda in morning (08:00Am to 12:00PM) and Dara at 14:00PM to 18:00PM. The existing birds were counted directly by total count methods at low tide. For accurate birds counting and determination, binocular 40×10 and telescope 15×60 was used. The birds were identified by studying their characteristic features in accordance with the identification keys evolved by Porter et al. [13], Colin [14], Baharat et al. [15], Sonobe & Usui [16] and Grimmett et al. [17].

## Statistical Analyses

Species diversity, similarity percentage, evenness and species richness between water birds' communities, in 2003, 2009, 2012, and 2016 were measured by Simpson's, Shannon-Wiener, Menhinnink, Margalef and Brillouin indexes as follow [18].

Simpson's index diversity:

$$1 - D = 1 - \sum_{i=1}^s \left[ \frac{ni(ni-1)}{N(N-1)} \right]$$

Where,

1-D = Simpson's index of diversity, Ni = Number of individual of species i in the sample, N = Total number of individuals in the sample =  $\sum ni$ , S = Number of species in the sample

Shannon-Wiener index as:

$$H' = \sum (pi)(\log_2 pi)$$

Where,

H' = Index of species diversity, pi=proportion of total sample belonging to ith species

Margalef index:

$$= \frac{S-1}{\ln N}$$

S= Number of species and N= total number of all individuals

Menhinnink index:

$$= \frac{S}{\sqrt{N}}$$

S= Number of species and N=total number of all individuals in sample.

Brillouin Index:

$$H = \frac{1}{N} \log \left( \frac{N!}{n1! + n2! + n3! + \dots} \right)$$

Where,

H=Brillouin index, N= Total number of individuals in entire collection, n1=Number of individuals belonging to species 1, n2= Number of individuals belonging to species 2, and

Evenness index:

$$\frac{D - D_{\min}}{D_{\max} - D_{\min}}$$

Where,

D = Observed index of species diversity, Dmin = minimum possible index of diversity given S and N, Dmax = Maximum possible index of diversity given S species and N individuals

Percentage similarity:

$$P = \sum \min imum(P1iP2i)$$

Where,

P = Percentage similarity between sample 1 and 2, P1i = Percentage of species i in community Sample 1, P2i = Percentage of species i in community sample 2.

Density analysis: The individual and total water bird densities for different years on Ghabre Nakhoda and Dara islands were calculated as numbers per hectare (Krebs 2001).

## Result and Discussion

### Species and Populations of Birds on Ghabre Nakhoda Island

Five species of terns and Western Reef Heron had bred on Ghabre Nakhoda Island in 2003, 2009, 2012, and 2016 (Table1). Average nests number of Lesser Crested Tern *Thalasseus bengalensis* were, 1200 nests (69.04%), (one egg on each nest, 1200 pairs), Swift Tern *Thalasseus bergii* 60 nests (3.4%) (one egg in each nest, 60 pairs) mixed with Lesser Crested Tern *Sterna bengalensis*, Bridled Tern *Sterna anethetus* 154 nests((8.86%) under the short bushes with 154 pairs, small colony of White-cheeked Tern *Sterna repressa*, 4 nests(0.23%), and Caspian Tern *Hydroprogne caspia* 49 nests(2.82%) with 49 pairs had been bred in four years. Lesser Crested Tern and Swift Tern had bred on sandy ground on the islands. The Western Reef Heron breed on short bushes of *Atriplex leucoclada*, on the islands. The breeding population of terns and Western Reef Heron declined from 3134 pairs in 2003 to 868 pairs in 2016. Reduction was 27.70% (Figure 3).

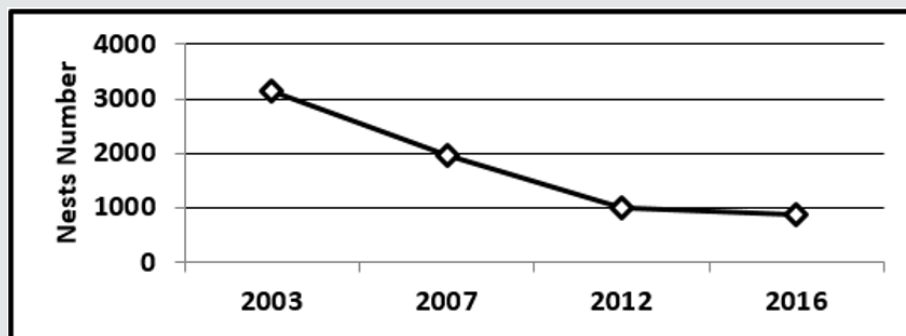


Figure 3: Number of nests of terns and Western Reef Heron on Ghabre Nakhoda Island on August 2003, 2009, 2012 and 2016.

Table 1: Comparison of number of nests of terns and Western Reef Heron on Ghabre Nakhoda Island on August 2003, 2009, 2012 and 2016.

	12 Aug. 2003	13 Aug. 2009	12Aug. 2012	15 Aug. 2016	Total	Average
Lesser Crested Tern	2551(81.38%)	1500(76.80%)	621(62.29%)	800(92.16%)	5472(78.71%)	1368(78.71%)
Swift Tern	120(3.89%)	110(5.63%)	11(1.10%)	8(0.92%)	249(3.3.58%)	63(3.58%)
Bridled Tern	310(10.05%)	250(12.80%)	254(25.48%)	54(6.22%)	868(12.48%)	217(12.48%)
White Cheeked Tern	10(0.32%)	6(0.30%)	12(1.20%)	0(0%)	28(0.40%)	7(0.40%)
Caspian Tern	120(3.89%)	75(3.84%)	87(8.73%)	0(0%)	282(4.05%)	71(4.05%)
Western Reef Heron	23(0.75%)	12(0.62%)	12(1.20%)	6(0.69%)	53(1.16%)	13(0.76%)
Total	3134(45.08%)	1953(28.09%)	997(14.34%)	868(12.77%)	6952(100%)	1738

The mudflats around Ghabre Nakhoda hold many hundreds of shorebirds and water birds in winter, also in summer, including large number of *Numenius arquata*, *Numenius phaeopus*, *Calidris minuta*, *Tring steganalis* and Laridae species (Table 2). Thirty-one species of water birds belonged to eight families were identified on this island from 2003 to 2016. (29 species in 2003, 30 species in 2009, 30 species in 2012 and 31 species in 2016) (Table 2). Counting was done at low tide and the area of the island was about 800 ha. Out of 31 species, the Crab Plover, Lesser crested Tern consisted more than 74.27 % of bird's community in four years

(Table 2). Five species were more than one percent and 24 species were less than 1%. Maximum birds were counted in 15 August 2016(8353 individuals 31.75%) and minimum birds were counted on 15 August in 2003(5657 individuals 21.50 %). Number of counted birds increased from 2003-2016, 5657<5941<6350<8353 (Figure 4), but the number of species was approximately stable (29-31 species). Comparing these numbers, it can be shown that the number of water birds increased (10.25%) (Figure 4), but the breeding pairs declined from 2003-2016(Figure 3).

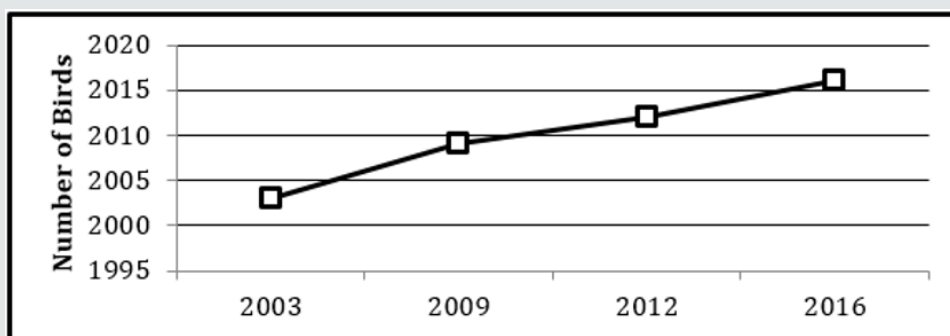


Figure 4: Total number of birds recorded in Ghabre Nakhoda Island on August in 2003, 2009, 2012, and 2016.

**Similarity of Water Birds Community on Ghabre Nakhoda**

Table 3 shows the similarity between birds within 4 years on Ghabre Nakhoda Island. Similarity of breeding species was more than 70% within four years. The lowest similarity was between

2012 and 2016(70.12). The similarity between birds observed within four years were more than 70%. Highest similarity was 86.15 % (between 2009 and 2012) and lowest similarity was 58.01% between 2003 and 2016.

## Species Diversity

Ecological Methodology software by Krebs 2001 was used to determine and compare the diversity of the water birds on Ghabre Nakhoda Island. The total bird species richness (No. of species present Table 2) was maximum in 2016(31 species) and minimum in 2003(29 species). Shannon Wiener index ( $H'$ ) (Table 3) for total birds on Ghabre Nakhoda Island was on higher side with maximum

during August 2016(1.82) and minimum in 2009(1.401) The evenness for total birds was maximum in August 2016 (0.199) and minimum in August 2009(0.1353). The value of evenness was found highest (0.199) in 2016 and lowest (0.1353) in 2009. The Simpson's index of dominance was highest in 2003 ( $C=0.3451$ ) and lowest in 2012 ( $C=0.2742$ ). Marglef's richness Index varied between 3.24 (2003, 3.337 in, 2009, 3.312 2012 and 3.322 in 2016), (Table 4).

**Table 2:** Water birds of 31species recorded on Ghabre Nakhoda Island on August 2003, 2009, 2012, and 2016.

Species	12 Aug. 2003	13 Aug. 2009	12Aug. 2012	15 Aug.2016	Total	%
<i>Thalasseus bergii</i>	235	205	121	562	1123	4.27
<i>T. bengalensis</i>	3045	2345	2435	1830	9655	36.70
<i>S. anaethetus</i>	556	234	256	352	1398	5.32
<i>Hydroproge .caspia</i>	180	156	11	150	497	1.89
<i>S. nilotica</i>	2	2	3	13	20	0.007
<i>S. repressa</i>	12	11	45	68	136	0.52
<i>Larus genei</i>	343	343	432	250	1368	5.20
<i>L.ridibundus</i>	34	34	543	133	744	2.83
<i>L.cachinana</i>	12	14	23	80	129	0.49
<i>L. fuscus</i>	12	21	31	105	169	0.64
<i>Tringa totanus</i>	12	11	4	27	54	0.20
<i>T. stegnatilis</i>	6	1	31	41	79	0.30
<i>T. nebolaria</i>	0	1	11	20	32	0.12
<i>T. cinereus</i>	1	1	12	21	35	0.13%
<i>T. hypoleucos</i>	5	6	7	20	38	0.14
<i>Egrtta gularis</i>	28	14	33	83	158	0.60
<i>E. garzetta</i>	3	3	12	21	39	0.15
<i>Ardea cinerea</i>	5	1	13	21	40	0.16
<i>Ricurvirostra avosetta</i>	3	1	21	39	64	0.24
<i>Haematopus ostralegus</i>	5	1	6	22	34	0.13
<i>Chradrius dubius</i>	0	1	6	21	28	0.10
<i>Ch.alexandrinus</i>	1	6	12	23	42	0.17
<i>Calidris. temminckii</i>	4	0	34	38	76	0.29
<i>C. minuta</i>	3	3	45	106	157	0.60
<i>C. alpina</i>	4	5	1	17	27	0.10
<i>Tringa totanus</i>	8	1	24	35	68	0.26
<i>Numenius arquata</i>	3	12	12	48	75	0.28
<i>N. phaepus</i>	7	4	31	63	105	0.40
<i>Gallinago media</i>	4	3	1	9	17	0.06
<i>Arenaria interpres</i>	4	1	0	7	12	0.45
<i>Dromas ardeola</i>	1120	2500	2134	4128	9882	37.57%
Water Bird Number total	5657(21.50%)	5941(22.59%)	6350(24.14%)	8353(31.75%)	26301	100
Water bird population density	7.07	7.42	7.93	10.44	32.87	-
Water birds Species total	29	30	30	31	31	-

**Table 3:** Similarity percentage of water bird's community on Ghabre Nakhoda Island on August in 2003, 2009, 2012, and 2016.

Similarity of Breeding water birds	2003	2009	2012	2016
2003	100			
2009	95.28	100		
2012	78.16	80.95	100	
2016	89.23	84.56	70.12	100
Similarity of Observed Water birds				
2003	100			
2009	77.26	100		
2012	73.14	86.15	100	
2016	58.01	78.83	72.71	100

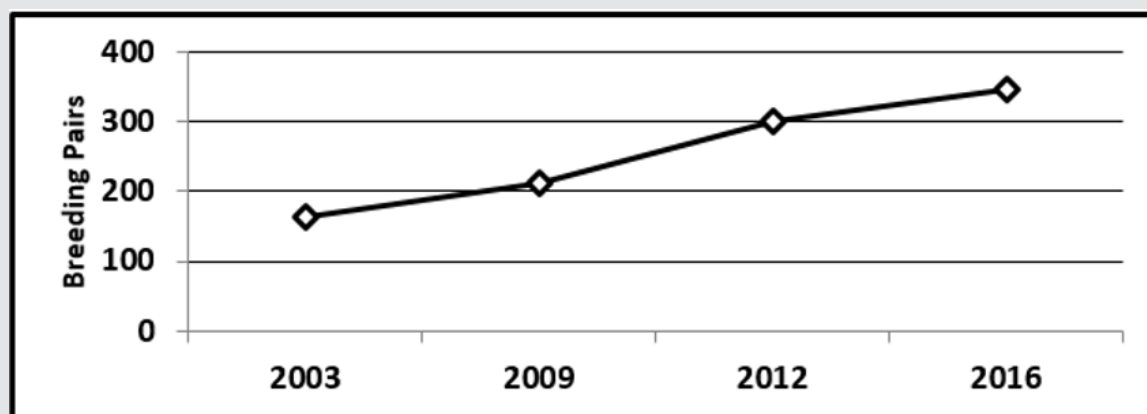
**Table 4:** Species diversity, richness and evenness of birds on Ghabre Nakhoda on August in 2003, 2009, 2012 and 2016.

Indices /year	2003	2009	2012	2016
Dominance _D	0.345	0.339	0.274	0.300
Simpson_1-D	0.654	0.660	0.685	0.699
Shannon _H	1.489	1.401	1.710	1.820
Evenness _e^ H/S	0.152	0.135	0.184	0.199
Brillouin	1.478	1.391	1.698	1.809
Menhinick	0.385	0.389	0.376	0.339
Margalef	3.24	3.337	3.312	3.322
Equitability _J	0.442	0.411	0.502	0.529

### Species and Populations of Birds on the Dara Island

Dara Island is Greater than Ghabre Nakhoda, with a chain of high vegetated dune along its western and eastern margins and around the southern end. The central part of island covering by water during high tide is without plant (Figure 2). Western part of island covered by vegetation is a suitable place for breeding of Bridled Tern. Nests of the breeding birds were counted at high tide and the area of island was 160 ha (Figure 1). Five species in 2003 six species in 2009, four species in 2012 and four species in 2016 had been bred on this island (Table 5). Breeding bird's population increased from 164 pairs in 2003 to 347 pairs in 2016 (Figure

5). Breeding pairs of birds increased about two times. The Lesser Crested Tern was the dominate breeder species and breeding population of this species increased from 110 pairs in 2003 to 506 pairs in 2016. 142 pairs of Bridled Tern had bred in 2016 but had not bred in 2003. White-cheeked Tern had not bred in 2012 and 2016, but had bred in 2003 and 2009 (Table 5). In general, the total breeding population increased from 2003 to 2016 (Figure 5). Eighteen species of water birds were identified on the island in 2003, 2009, 2012, and 2016, (Table 6). Population of these 18 species increased from 4007 in 2003 to 5083 individuals in 2016 (Figure 5). Counting was done at low tide and the area of the island was about 500 ha.

**Figure 5:** Total number of nests of terns and Western Reef Heron on Dara Island on August in 2003, 2009, 2012 and 2016.

**Table 5:** Total number of nests on Dara Island on August 2003, 2009, 2012 and 2016.

Species	12 Aug. 2003	13 Aug. 2009	12Aug 2012	15 Aug. 2016	Total	Average
Lesser crested Tern	110(67.07%)	142(66.98%)	165(55%)	189(60.54%)	506(61.48%)	127(49.60%)
Swift Tern	12(7.32%)	8(3.77%)	4(1.33%)	4(2.72%)	28(3.40%)	7(2.73%)
Bridled Tern	0(0%)	50(23.58%)	123(41%)	142(28.57%)	215(26.12%)	54(21%)
White Cheeked Tern	10(6.10%)	6(2.83%)	0(0%)	0(0%)	16(1.94%)	4(1.57%)
Caspian Tern	30(18.29%)	5(2.36%)	0(0%)	0(0%)	35(4.25%)	9(3.41%)
Western Reef Heron	2(1.22%)	1(0.47%)	8(2.66%)	12(8.16%)	23(2.79%)	6(2.34%)
Total	164(16.03%)	212(20.72%)	300(29.32%)	347(33.91%)	1023	256

**Table 6:** Water birds of 18 species recorded on Dara Island on August 2003, 2009, 2012 and 2016.

species	12 Aug. 2003	13 Aug. 2009	12Aug 2012	15 Aug. 2016	Total	Average
<i>Phoenicopterus ruber</i>	6	4	0	0	10	0.05
<i>Thalasseus bergii</i>	45	65	54	45	209	1.20
<i>Thalasseus bengalensis</i>	56	23	95	65	239	1.37
<i>S. anaethetus</i>	2931	2341	2122	651	8045	46.23
<i>S. hirundo</i>	2	89	123	12	226	1.30
<i>S.repressa</i>	12	142	119	6	279	1.60
<i>Larus genei</i>	134	123	133	321	711	4.08
<i>Larus fuscus</i>	123	12	277	108	520	2.99
<i>Larus ridibundus</i>	165	65	94	201	525	3.01
<i>Egrtta gularis</i>	32	45	112	65	254	1.46
<i>Egretta garzetta</i>	6	16	0	21	43	0.25
<i>Ardea cinerea</i>	17	21	12	41	91	0.52
<i>Ricurvirostra avosetta</i>	0	6	1	9	16	0.09
<i>Haematopus ostralegus</i>	0	8	1	0	9	0.05
<i>Numenius arquata</i>	12	65	23	52	152	0.87
<i>Numenius phaepus</i>	16	81	11	65	173	0.99
<i>Dromas ardeola</i>	450	879	1150	3421	5900	33.90
<i>Arenaria interpres</i>	0	2	0	0	2	0.01
Total	4007(23.02%)	4087(23.48%)	4327(24.86%)	5083(29.20%)	17404	100
Water bird's population Density	8.01	8.17	8.65	10.66	34.80	-
Species number	15	18	15	15	18	-

## Species Diversity

Diversity is a major aspect of species structure in avian community. Ecological Methodology software by Krebs 2001 was used to determine and compare the diversity of the water birds on Dara Island. Table 7 shows the diversity of water birds on Dara Island in 2003-2016. The Shannon's index of diversity was found highest ( $H=1.66$ ) in 2016 and lowest ( $H=1.078$ ) in 2003. The value of evenness was found highest (0.3186) in 2012 and lowest (0.196) in 2003. The Simpson's index of dominance was highest in 2003

( $C=0.5519$ ) and lowest in 2012 ( $C=0.3196$ ). Krebs (2001) stated that this index gives relatively less importance to rare species and more to common species [18]. The value of Simpson's Index in the 2012 was 0.6804 i.e. closer to '1', thus, having higher dominance as compared to the value 0.4481 (closer to 0), indicating the lower dominance in August 2003. Simpson (1949) opined that dominance varies inversely with diversity which is in consonance to the present observations) [19]. Marglef's richness Index varied between 1.641-2.05 (1.688 in, 2003, 2.05 in 2009, 1.672 in 2012 and 0.1.641 in 2016).

**Table 7:** Species diversity, richness and evenness of water birds on Dare Island.

	2003	2009	2012	2016
Dominance_D	0.551	0.397	0.319	0.476
Simpson_1-D	0.448	0.602	0.680	0.523
Shannon_H	1.078	1.418	1.564	1.665
Evenness_e^ H/S	0.196	0.229	0.318	0.236
Brillouin	1.069	1.407	1.555	1.257
Menhinick	0.237	0.285	0.228	0.210
Margalef	1.688	2.05	1.672	1.641
Equitability_J	0.398	0.4906	0.577	0.467

### Similarity

The similarity percentage of water bird's community among four years on Dara Island has been showed in Table 8, it shows there is some difference between breeder species (5 species in 2003 and 4 species in 2016) and breeding population of water birds (164 to 347 pairs) in August 2003 and 2016. These two numbers show that the number of water birds increased (21.17%) in 2016 (Table 6). Despite the differences in the populations of water birds, the similarity between observed species and population were more than 70%. Highest similarity was between 2009 and 2016(79.68%) for breeding birds, the lowest similarity was between 2003 and 2012 (57.55%). Highest similarity was between 2009 and 2016 for observed birds and lowest similarity was between 2003 and 2016.

**Table 8:** Similarity percentage of water bird's community among four years on Dara Island.

Similarity of breeding water birds	2003	2009	2012	2016
2003	100			
2009	76.42	100		
2012	57.55	70.39	100	
2016	57.84	79.68	99.21	100
Similarity of Observed Water birds				
2003	1			
2009	79.18	1		
2012	73.09	85.14	1	
2016	37.86	46.20	51.64	1

### Bird Species Dominance

Dominance results when one or several species control the environment and conditions that influence associated species [20]. A total of 31 species were observed and recorded in and around islands covering both, waders and wading birds. The results indicate that overall 5 bird species dominated the area in terms of relative abundance (Tables 2 & 6). It was revealed that Bridled Tern *Sterna anaethetus* was the most dominant (46.23%) followed by Crab Plover *Dromas ardeola* (33.90%), Slender-billed Gull *Larus genei*(4.08%), Black Headed Gull *Larus ridibundus* (3.01%) on Dara

Island, but on Ghabre Nakhoda, Crab Plover (37.57%) followed by Lesser Crested Tern (36.70%) and Bridled Tern were dominant species (Tables 2 & 6). Two species Bridled Tern (12.48%) and Lesser Crested Tern (78.71%), were dominating breeders on Ghabre Nakhoda Island in 2003-2016 (Table 1), but on Dara Island Lesser Crested Tern (49.60%) and Bridled Tern (21%) were dominant species (Table 5).

### Threat and Conservation

Ghabre Nakhoda and Dara islands located in Khore Mosa, which is part of Shadegan marsh and this wetland is Ramsar site and wildlife refuge [5,11,21]. Wildlife refuge of 296000 ha, encompassing all the main wetland areas and the coastal mudflats in the south was established in 1972 and has remained since then [21]. The central and southern portions of Shadegan marsh and the mudflats of Khore-Al-Omayeh and Khore Mosa (a total of 400000 ha.) were designated as a Ramsar site on 23 June 1975[9,11,21]. The site has been identified as an "Important Bird Area" by Birdlife International [11]. Egg-collecting, chick and female harvesting when the females sited on eggs, roosting and staying of fishermen on island (Figure 6), illegal hunting, Pollution of water bodies by chemical compounds of oil Tankers, motor boats and factories are serious treats to the breeding population of birds [21]. Poaching is practiced particularly in the waters around islands. Oil pollution has been reported on the beaches around Bandar Imam in the southeast [5]. The breeding success of the species is sensitive to food availability, predator presence, and human disturbance and oil pollutions in Khore Mosa [22].

### Conclusion

Khore Mosa is an economically and environmentally strategic creek in Persian Gulf. There are six sandy offshore islands in Khore Mosa. Khore Mosa and the southern estuaries of the Shadegan marshes are among the most important intertidal habitats of Persian Gulf shoreline. It holds considerable commercial and non-commercial aquatic species and populations. The creeks and islands in Khore Mosa are suitable habitats for fishing and harvesting of shrimps and other aquatic species. The specific conditions of the Khore Mosa, combined with high nutrient content of this water body, provide attractive conditions for many fish, shrimps and birds' species to use it as, nursery, breeding and feeding habitat [21]. Terns, waders and gulls form main animal group heavily dependent in the Persian Gulf islands for their continued existence. There are many species of these seabirds on the islands and also on Ghabre Nakhoda and Dara, but six species in particular nest in vast number on the islands. These are the Western Reef Heron *Egretta gularis*, Lesser Crested Tern *Thalasseus bengalensis*, White-cheeked Tern *Sterna repressa*, Swift Tern *Thalasseus bergii*, Bridled Tern *Sterna anaethetus* and Caspian Tern *Hydroprogne caspia*. All six species occur together on Ghabre Nakhoda and Dara Islands, but each has distinctive nesting habitats, (Figure 1). Ghabre Nakhoda



is ecologically extremely important for breeding and wintering of many migratory water bird species, as well as a breeding site for Marine Turtles [11]. Ghabre Nakhoda island is habitat for breeding birds, including at least 2 pairs of *Egretta garzetta* in 2003 (this species did not breed in 2009, 2012, and 2016), five terns' species, all together more than 3134 pairs in 2003, 1953 pairs in 2009, 997 pairs in 2012 and 868 pairs in 2016, (Table 1) and (Figure 2). Tuck (1974) reported, Mudflats around of this island are important staging and feeding habitat for a wide variety of shorebirds, Gulls and Terns [23] (Table 2), including up to 744 *Larus ridibundus*, 1368 *Larus genei*, 169 *Larus fuscus*, 9882 *Dromas ardeola*, 75 *Naumenius arquata*, 105 *Naumenius phaopus*. Ghabre Nakhoda, south most island and furthest offshore, is c.3 ha, almost elliptic, and composed mainly of sand with some rocky shores in the south and west. It is fringed with low dune who encircles a central basin almost completely covered in dance, low scrub. Main plant community of the island is *Atriplex+Stipa+Suaeda+Halostachys*. Lesser Crested Tern and Swift Tern often make their nests on the bare ground, where each pair incubates a single egg, soon after hatching, the young congregate in a flock "crèche" near the water's edge, where they are fed by their parents until fledging [24]. These two species unable to colonies areas with too high or too dense vegetation, but nest sites of the Bridled Tern differ according to vegetation cover, height of vegetation and other characters of micro-habitat [24,25]. The Bridled Tern prefers place with a certain degree of cover (Minimum 70%), or even totally covered. Nests of this species are very simple and make under the scrubs especially under the *Suaeda sp* and *Atriplex sp* (Figure 2). Nests of the White Cheeked Tern are well spaced out on the beach flat and are often neatly built of twigs. Two eggs are the usual complement, and the young remains near the nest during the fledging period. All four Tern species occur together on Ghabre Nakhoda and Dara islands, but each has distinctive nesting habitat. Khore Mosa complex (Channels, islands,

beaches, mudflats and sand hills) is the most important habitat for water birds in Persian Gulf. For this reason, Khore Mosa complex was suggested for classification as sensitive habitat for breeding water birds, [7], but egg-collecting, chick and female harvesting, when the females site on eggs are serious treats to the breeding population of terns and Crab Plover (Figure 6). Density of bird's population increased from 7.07 to 10.44 and 8.01 to 10.66 on Ghabre Nakhoda and Dara respectively from August 2003 to 2016, but breeding population reduced 27.69% on Ghabre Nakhoda Island and increased more than two times in Dara from 2003 to 2016. Comparing these numbers shows, the breeding population move between to islands. When breeding population of terns on Ghabre Nakhoda island decrease, it leads to an increase on Dara Island. Little Egret had bred only on Gabre Nakhoda Island in 2009(2 pairs) and 2 individuals of Ruddy Turn stone *Arenaria interpres* had observed in 2009 on Dara Island. Ghabre Nakhoda and Dara islands are more sensitive habitats during summer, because 6 species of water birds (Crab Plover, Swift and Lesser Crested Tern, Bridled Tern and White-cheeked Tern Caspian Tern) breed regularly on these islands. Breeding population of Crab plover on Dara Island was 11500 pairs in 2013, but I could not count the nests of this species in 2016, thus breeding population can't be compared between 2016 and 2003-2012. The destruction of historical nesting and feeding grounds has forced water birds to compete for diminishing resources (Figure 6). Clearing and degradation of fringing and littoral island vegetation reduces water bird breeding success as a consequence of the loss of habitat and increased vulnerability to predation by a range of species. The following measures should be taken during Breeding time to protect nests and birds on the two islands. The islands are required to be stopped appropriately to check the fishermen boats anchor to prevent further Population loss of breeding birds. Strengthen enforcement of existing restrictions on the hunting of breeding birds [26].

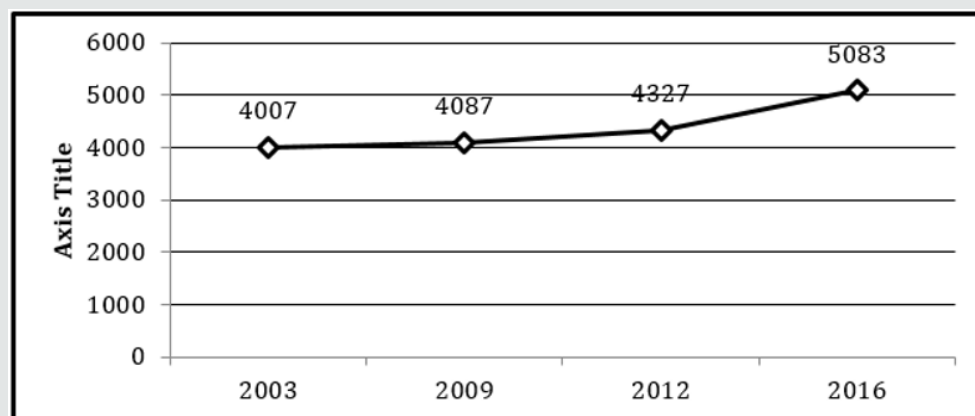


Figure 6: Total number of birds recorded on Dara Island on August in 2003, 2009, 2012 and 2016.

a. The breeding success of the species is sensitive to food availability, predator presence, and human disturbance and oil pollutions in Khore Mosa, for these reasons Khore Mosa complex need to be protected during breeding season.

b. It is recommended to initiate study of bird diversity and population status immediately with periodic monitoring in all islands for their conservation and management.

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