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Species and breeding population of waterbirds on four islands in Kore Mosa in Persian Gulf in 2003 and 2012

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The research was conducted in Ghabre Nakhoda, Nedelghar, Dara and Boneh islands in Khore Mosa Ramsar site in the Persian Gulf from May to December 2003 and 2012. Total count method was used to obtain the census of the nests and breeding population of waterbirds on the Islands. Thirty three (34) species of waterbirds were identified, of which eight species were breeders. The maximum breeding population of Lesser Crested Tern *Sterna bengalensis,* Swift Tern *sterna bergii,* Caspian Tern *Sterna caspia*, Bridled Terns *sterna anaethetus*, Western Reef Heron *Egretta gularis* and Crab Plover *Dromas ardeola* were 2551, 124, 120, 1310, 23 and 10500 pairs, respectively. Only two pairs of Little Egret *Egretta garzetta* had been bred in 2003 in the Ghabre Nakhoda. The islands have been identified as an "important bird area" (as a part of Shadeghan marsh) by Birdlife International proposed for protection as a part of the wildlife refuge of Shadeghan and suggested for to be classified as sensitive habitat for breeding seabirds.

Key words: Breeding species, nest number, species diversity, Persian Gulf.

INTRODUCTION

There are 34 islands on northern part of Persian Gulf belonging to Iran, four of them are located in Khore Mosa Creek Ramsar site (30°17'58"N 48°56'51"E) in Khuzestan province, (Figure 1). These islands provide ideal breeding grounds for large colonies of seabirds, (Scott, 1995 and 2008; Evans, 1994; Behrouzi-Rad and Tayfeh, 2008; Behrouzi-Rad, 2008, 2013). The islands are also important for nesting sea turtle, including Hawksbill Turtle *Eretmochelys imbericata* (a globally threatened species) (Scott, 1995). In the other hands, several aspects of the ecology of waterbirds make them useful as bio-indicators. Frist, waterbirds have been shown to track environmental variations, at short (months) and long (years) temporal scales, and at both species and community level (Redon et al., 2008; Almarez and Amat, 2004). Second, because many species are top predators, several contaminants often accumulate along the tropic chain, such species may be used as indicators of changes occurring at lower tropic level (Matsinos and Wolf, 2003; Burger and Eichhorst, 2005). And third, either the waterbirds themselves or their prey are exploited by humans (for example, hunting and fisheries), so that hunting bags of waterbirds may be indicative of productivity in nesting or wintering areas (Miller et al., 1998) or breeding parameters of birds may inform on fish stock (Enoder, 2009).

On the other hand, to monitor a group of birds implies that there is a need for information on the population status or health that can only be met by collecting data, because every species has a range of conditions under which it thrives. Removal of any component of those conditions and the species disappears or no longer successfully reproduces (Wetland International, 2007). Thus the continued presence of a species is an indication that the environmental conditions which it requires remain. By choosing to monitor a set of species that require high quality environments, specialized habitats, or conditions that a

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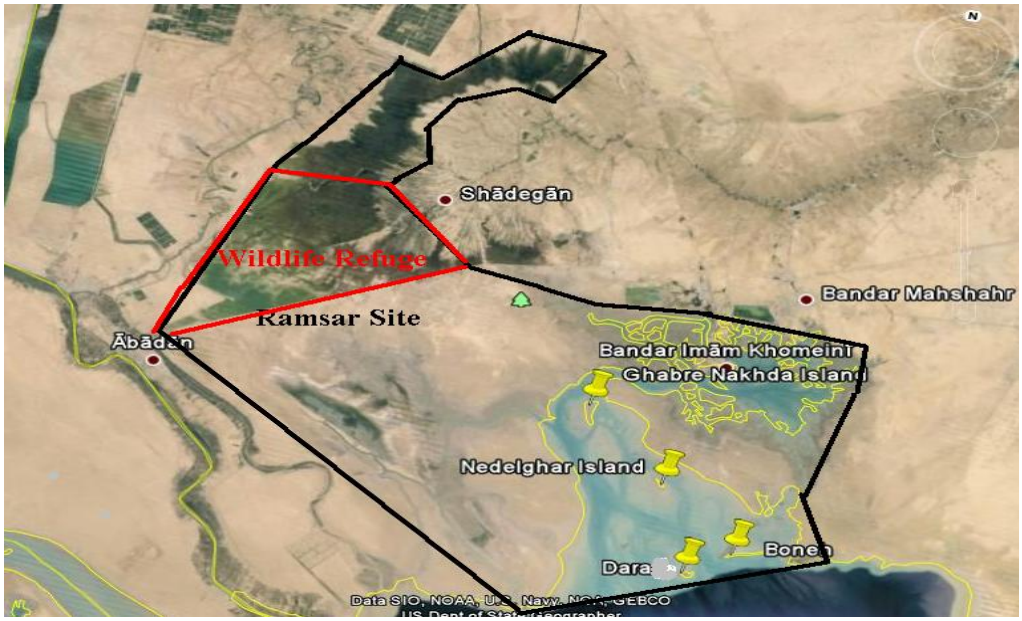

Figure 1. Location of Ghabre Nakhoda, Nedelghar, Boneh and Dara Islands in Khore Mosa in Persian Gulf.

manager may want to promote a sense of the region's environmental health can be made.

Since environmental or habitat health is often difficult for us to measure directly, due to the many factors (often unknown or ephemeral) that contribute to the conditions, it is often easier to measure the status of the breeding species that require them to develop an assessment. Also, it is widely accepted that the number of waterbirds using a site is a good indicator or that site's biological importance (Wetland International, 2007), and they are also important indicators of the ecological condition of their habitats. On the other hands, migratory waterbirds are one of the most remarkable components of global biodiversity.

This study was designed to obtain information on the presence, breeding species, breeding population and species diversity of waterbirds on the islands in 2003 and 2012, because of suggested classification as sensitive habitat for breeding waterbirds (Behrouzi-Rad, 2008).

MATERIALS AND METHODS

Study area

The study area located in Khore Mosa Creek near Bandar Imam (Imam Port) (30°17'58"N 48°56'51"E, Figure 1) and involves a particular natural habitats in Persian Gulf. Khore Mosa extends from Mahshahr port in the north, south to the Persian Gulf. This creek is 60 km totals in length and is a part of Shadegan marsh the Ramsar site. Khore Mosa Creek and small creeks around it are most important intertidal habitats of the Persian Gulf shoreline. There are 4 main islands in the Khore Mosa, named Ghabre Nakhoda.

The Ghabre Nakhoda Island located in middle of Khore Mosa (30°21'83"N 48°55'10"E) (Figure 1) and cover an area 4.2 to 500 ha, (Figure 2). There is a Grave in the middle of this island named Ghabre Nakhoda (Ghabr means Grave and Nakhoda meaning is Captain). The second island is Dara and located at the entrance of Khore Mosa Creek to Persian Gulf (30°06'06"N 49°06'06"E) (Figure 1) and cover an area 160 to 200 ha, (Figure 3).

Third one is located (30°08'25" N 49°09'21"E) 5 km far from west of Dara. This is the largest of the four islands, and a small village located on west part of the island (Figure 1). It is long and narrow, tow east and west margin of the island covered by density various plant species. Central part of the island is without any plant species. At low tide the area of the island is about 1500 ha. A small part on east margin of island is bare ground with less vegetation about one hectare. Usually waterbirds breeds on this part of the island (Figure 4).

There is another small island (less than two hectare and about 100 ha in ebb named Nedelgar, without any vegetation cover (30°14'90"N 49°02'86"E) (Figure 5). All four islands are flat, sandy and Shelly; 70 to 90% of area of the Dara, Ghaber Nakhoda and Boneh islands covered by vegetation in February and March (Figures 2, 3 and 4), but the Nedelghar is without any vegetation (Figure 5). All around the islands are mudflats. Main plant community of islands is *Atriplex+ Stipa+ Suaeda+ Halostachys*.

The main plant species of this community are *Atriplex leucoclada, Stipa capensis, Suaeda fruticosa, Halostachys belangeriana, Calanderula persica, Malva* sp., and *Cistanche tubolusa.* There is another plant community in Ghabre Nakhoda, *Calendula+ Cistanche*. Sandy soil rich in oyster shell are covered with this community.

Cistanche tubolosa is a vulnerable species in this community. *Calendula persica* is an endemic species. One of the main roles of this plant community is conservation a surface soil against erosion. In the undulating part of the islands, this community stabilizes the Crab Plover nests and provides a shelter over them.

All four islands are devoid of fresh water, uninhabited, hot in summer (45°C) and moderate in winter, their main inhabitants are the seabirds, but also sea turtles are present annually in spring and summer. These islands are propitious environment for nesting and breeding for migratory waterbirds as well as sea turtles.

Figure 2. Nesting sites and birds count area on Ghabre Nakhoda Island (Photo: Behrouzi-Rad, Feb. and Aug. 2012).

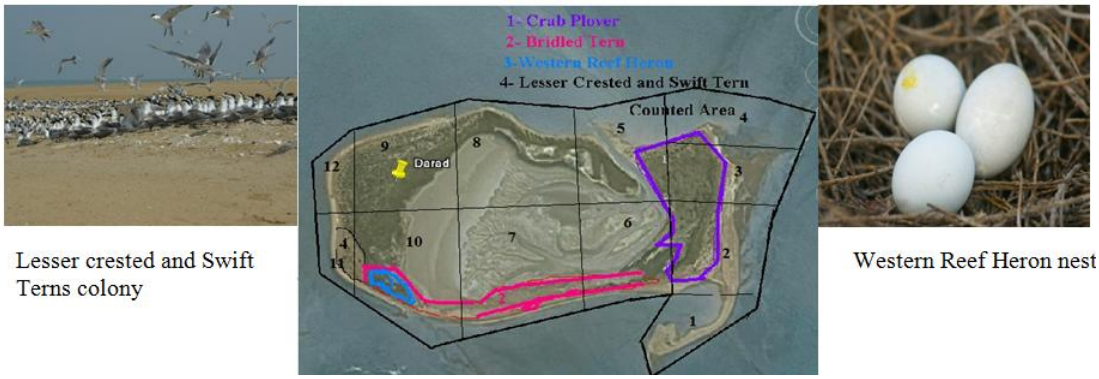

Figure 3. Study area, nesting sites and birds count routs on Dara Island (Number one to twelve are the squares that birds have been counted in them) (Photo: Behrouzi-Rad, Aug., 2003).

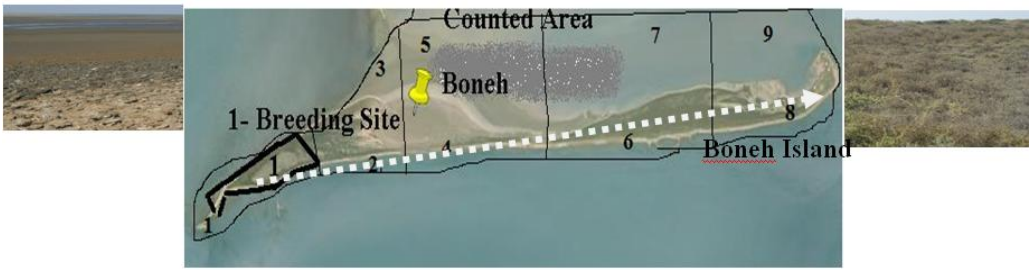

Figure 4. Study area, nesting sites and birds count rout on Boneh Island (Number one to nine are the squares that birds have been counted in them) (Photo: Behrouzi-Rad, Aug., 2012).

Breeding bird's population count

Nests of breeding species of waterbirds were counted directly on 20 August in 2003. 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 3), but for the Crab Plover, I counted holes (like tunnel) that had been made by this species for egg-lying. The nests of Bridled Tern were under the short bushes, and were counted by looking under the bushes. The non-breeders counted done on 15 may, 15 November and 20 December in 2003 by total count methods at low tide (Wetland In

Figure 5. Nedelghar Island and birds count rout on it (Number one to nine are the squares that birds have been counted) (Photo: Behrouzi-Rad, 2012).

ternational, 2007; Conway, 2005). The islands were visited 4 times again in May (10 to 11), August (2 to 3), November (6 to 7) and two days on December (12 to 13) in 2012. Total count method was used again for counting the birds and nests on islands as the same method in 2003 and number of nests multiplied in tow for getting the breeding populations of birds. The first observation was done on May 2003 and 2012. At this time breeding birds started to migrate to the islands. Second counted was done on August, which all breeding species established nests and laid egg. Third and fourth counts were done after breeding time on November and December in 2003 and 2012. All species observations around the islands were confirmed with binocular (10 × 40 mm).

Statistical analyses

Species diversity, percentage similarity, evenness and species richness between waterbirds communities, in 2003 and 2012 were measured by Simpson's, Shannon- Wiener, Menhink, Margalef and Brilouin indexes as fallow (Krebs, 2001).

Simpson's index diversity:

$$1 - D = 1 - \sum_{i=1}^{s} \frac{n_i(n_i-1)}{N(N-1)}$$

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 = ∑ni,
S = Number of species in the sample.

Shannon-Wiener index as: H'=∑ (pi)(log2pi)

Where,
H' = Index of species diversity, pi=proportion of total sample belonging to i th species
Marghalef index: $= \frac{s-1}{lnN}$ S= Number of species and N= total number of all individuals
Menhink index = $\frac{s}{\sqrt{N}}$ S= Number of species and N=total number of all individuals in sample.

Brilouin Index: $\hat{H} = \frac{1}{N} \log\left(\frac{N!}{n_1!\, n_2! n_3! \ldots\ldots}\right)$

Where,
H=Brilouin 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:$P = \sum \text{minimum}\,(P_{1i}P_{2i})$

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

RESULTS

Species and populations of birds on the Ghabre Nakhoda Island

Thirty two species of waterbirds were identified in this island in 2003 and 2012, (Table 1). Four Larus species (non-breeding) were dominant during study months in 2003 and 2012 (Table 1). Maximum birds were counted on 19th August (12721 individuals), in 2003 and 6220 individuals in 9thAugust 2012, because at this time all the breeding birds were nested and present on island. Minimum number of birds was counted in November 2003 and 2012, because the breeding species of birds has left the island at this time. In total, 8591 birds were counted in 2003 and 6909 individuals in 2012 (Table 1). Comparing

Table 1. Waterbirds of 32 species recorded at Ghabre Nakhoda Island on May, August, November and December in 2003 and 2012 (Area 500 ha).

Species	Ghabre Nakhoda 2003				%	Ghabre Nakhoda 2012				%
	15th May	20th August	15th November	20th December		10th May	2sec August	6th November	12th December	
Phalacrocorax carbo	0	0	0	5	0.05	0	0	0	5	0.70
Sterna Bergii	132	235	1	0	4.28	23	205	1	1	3.32
S.Bengalensis	150	3045	5	0	7.24	121	2345	5	0	5.76
S. anaethetus	120	556	6	0	7.93	111	234	3	0	5.56
S.caspia	4	180	3	2	2.19	4	156	3	2	2.39
S.nilotica	3	2	6	0	0.12	3	2	4	0	0.13
S.repressa	0	12	0	0	0.13	0	11	0	0	0.16
Larus genei	34	343	32	245	7.61	34	343	32	172	4.40
L.ridibundus	23	34	122	245	4.93	23	34	122	421	8.68
L. canus	47	12	31	18	1.25	34	14	32	21	1.46
L.fuscus	43	12	141	285	5.6	10	21	151	201	5.54
Tringa totanus	9	12	0	15	0.42	7	11	2	8	0.41
T. stegnatilis	0	6	3	9	0.21	2	1	5	4	0.17
T. nebolaria	1	0	8	12	0.24	11	1	2	3	0.24
Egrtta gularis	11	28	8	15	0.71	9	14	6	15	0.63
E. garzetta	3	2	4	2	0.13	1	3	3	2	0.09
Ardea cinerea	12	3	4	13	0.37	13	1	3	6	0.33
Ricurvirostra avosetta	0	5	12	6	0.27	0	1	7	8	0.23
Haematopus ostralegus	0	3	12	5	0.23	0	1	7	3	0.16
Charadrius alexsandrinus	0	5	0	5	0.11	0	6	0	4	0.14
Ch. Dubius	0	1	13	6	0.23	0	1	11	6	0.26
Ch. Temminkii	0	0	4	6	0.11	0	0	4	8	0.17
Ch.minuta	12	4	6	11	0.38	14	1	2	15	0.46
Numenius arquata	8	8	16	16	0.59	1	12	5	8	0.38
N. phaepus	5	3	25	25	0.67	2	4	30	16	0.75
Tring hypolacus	1	7	0	0	0.93	1	6	1	5	0.19
Gallinago media	0	5	0	0	0.58	0	3	0	0	0.4
Caldris minuta	21	4	54	13	1.07	2	3	76	11	1.33
C. alpinus	0	3	8	3	0.16	0	5	9	8	0.31
Arenaria interpres	2	4	2	0	0.93	12	1	3	0	0.23
Xenus cinereus	0	2	6	0	0.93	0	1	4	0	0.07
Dromas ardeola	780	1120	4	16	22.35	650	870	1	23	22.34
Mountly waterbird total numbers species	1421 (16.54%)	5656 (65.83%)	536 (6.23%)	978 (11.38%)	100	1088 (15.74%)	4311 (62.39%)	534 (7.72%)	976 (14.12%)	100
Sum of four month			8591		-		6909			-
Monthly waterbird species totals	20	28	26	23	-	22	30	28	25	-
Waterbird population density*	2.84	11.31	1.07	1.95	-	2.17	8.62	1.06	1.95	-
Average population density*		4.29			-		3.45			-

these two number it shows that the number of waterbirds reduced (19.75%) in 2012 (Table 1). Eight species of waterbirds had been bred on Ghabre Nakhoda Island in 2003 and three species in 2012, (Table 2), reduction was

Table 2. Comparison of the Number of nests of waterbirds in 2003 and 2012.

Species	Ghabre	Nakhoda	Dara		Boneh		Nedelghar
	20th Aguust 2003	3th August 2012	20th August 2003	3th August 2012	20th August 2003	3th August 2012	2003 and 2012
Lesser crested Tern	2551	0	0	505	130	45	0
Swift Tern	124	0	0	46	12	8	0
Bridled Tern	310	154	1452	806	112	51	0
White Cheeked Tern	10	0	0	0	0	0	0
Caspian Tern	120	0	17	0	0	0	0
Western Reef Heron	44	12	14	18	0	0	
Crab plover	1420	1201	230	10500	0	0	0
Little Egret	2	0	0	0	0	0	0
Total nests	4581 nests in 4.2 ha	1367 nests in 4.2 ha	1713 nests In 160 ha	11875 nests In 160 ha	254 nests In 180 ha	104 nests In180 ha	0 nests
Number of Species	8	3	4	5	3	3	0
Nests density	1090.71 nests/ha	325.47 nests/ha	10.70 nests/ha	74.21 nests/ha	1.41 nests/ha	0.57 nests/ha	0 nests/ha

62.5%. Five Tern species, Lesser Crested Tern *sterna bengalensis*, Swift Tern *Sterna bergii*, Bridled Tern *Sterna anethetus*, Caspian Tern *Sterne caspia* and White Cheeked Tern *Sterna repressa* did not breed in 2012. Breeding population of Crab plover *dromas ardeola* declined from 1420 pairs in 2003 to 1201 pairs in 2012, reduction was 15.42%. Little Egret *Egretta garzetta* did not breed in 2012 (in 2003, 2 nest with four eggs in each of them was counted) (Table 2). Lesser Crested and Swift Tern had been bred in a mixed colony on sandy part on north of island, (Figure 2). These parts of island are dry during year and never drown under water even in high tide, (Figure 2). Area of this part of the island is about 4.2 ha.

Species and populations of birds on the Dara Island

Eighteen species of waterbirds were identified on the island in 2003 and 2012, (Table 3). Counting was done at low tide and the area of the island was about 200 ha. Dara is smaller than Boneh and Greater than Ghabre Nakhoda, with a chain of high vegetated dunce along its western and eastern margins and round the southern end. The central part of island covering by water during high tide is without plant (Figure 3). Southern margin of island covered by vegetation is a suitable place for breeding of Bridled Tern. Crab Plover breed on eastern part of the island. Nests of the breeding birds was counted at high tide and the area of island was 160 ha (Figure 3). Four species in 2003 and 5 species in 2012 had been bred on this island (Table 2). The Crab plover was the dominant breeder species and the breeding population of this species increased from 230 pairs in 2003 to 10500 pairs in 2012. Seventeen (17) pairs of Caspian Tern had bred in 2003, but were not bred in 2012. Lesser Crested and Swift Tern had not bred in 2003, but was bred in 2012 (Table 2).

Species and populations of waterbirds on the Boneh Island

Twenty three (23) species of watebirds identified on the Boneh during study months (Table 4). Three gull's species were dominant. The population of these species was 3142 in 2003 and 1110 individuals in 2012. Total number of waterbirds were 5243 in 2003 and reduced to 2380 individuals in 2012 (reduction was 54.60%). Average density of waterbirds population was 0.87 in 2003 and 0.39 in 2012. Reduction of the density was 55.17% (Table 4). Three species of Terns had been bred on the island, (130 nests of Lesser crested Tern in 2003 and 45 nests in 2012, 12 nests of Swift Tern in 2003 and eight nests in 2012, and 112 nests of Bridled Tern in 2003 and 51 nest in 2012 counted) (Table 2). All breeding species

Table 3. Waterbirds of 15 species recorded at Dara Island on May, August, November and December in 2003 and 2012 (Area of island was about 200 ha.).

Species	Dara 2003					Dara 2012				
	15th May	20th Aug.	15th Nov.	20th Dec.	%	10th May	2sec Aug.	6th Nov.	12th Dec.	%
Phoenicopterus ruber	0	6	119	0	1.76	0	0	131	254	2.03
Sterna Bergii	12	45	5	12	1.04	11	54	3	1	0.36
S.Bengalensis	43	56	2	0	1.42	0	13	4	0	0.89
S. anaethetus	134	2931	3	2	43.34	123	2122	5	3	11.91
S. hirundo	3	2	12	2	0.26	1	2	6	0	0.47
S.repressa	3	0	0	12	0.211	7	9	0	2	0.09
Larus genei	116	134	554	455	17.77	111	133	229	217	3.64
L.fuscus	23	123	327	432	12.77	51	77	231	423	4.13
L.ridibundus	118	165	333	0	8.69	82	94	171	182	2.79
Egrtta gularis	2	32	0	2	0.5	11	12	3	4	0.15
Egretta garzetta	0	0	0	1	0.01	0	0	0	2	0.01
Ardea cinerea	12	17	12	11	0.73	13	12	11	13	0.25
Ricurvirostra avosetta	0	0	21	12	0.46	0	1	12	14	0.14
Haematopus ostralegus	0	0	4	2	0.08	7	1	4	0	0.6
Numenius arquata	27	12	42	32	1.59	14	23	46	22	0.55
Numanius phaepus	13	16	15	11	0.77	24	11	20	6	0.32
Dromas ardeola	145	450	3	2	8.47	2352	11500	5	11	73.32
Arenaria interpres	3	0	0	0	0.04	0	0	2	5	0.37
Monthly waterbirds numbers total *	654 (9.23%)	3989 (56.31%)	1452 (20.49%)	988 13.94%)	100	2807 (14.84%)	14064 (74.26%)	883 (4.66%)	1159 (6.12%)	100
Monthly waterbirds species total	14	13	14	14	-	13	15	16	15	-
Sum of four month		7083			-			18913		-
Waterbird population density	3.27	19.94	7.26	4.94		14.03	70.32	4.41	5.79	-
Average density		8.85						23.63		-

Table 4. Waterbirds of 23 species recorded at Boneh Island on May, August, November and December in 2003 and 2012.

Species	Boneh 2003					Boneh 2012				
	15th May	20th August	15th November	20th December	%	10th May	2nd August	6th November	12th December	%
Phoenicopterus ruber	0	0	0	212	4.10	0	0	0	23	0.98
Egrtta gularis	13	4	5	2	0.46	5	1	0	2	0.34
Ardea cinerea	15	12	23	11	1.17	3	8	21	6	1.62
Egretta garzetta	11	2	3	5	0.40	3	8	0	4	0.64
Ardea cinerea	12	3	2	9	0.50	2	4	1	2	0.38
Sterna Bergii	23	324	43	11	7.75	231	340	54	6	27.00
S.bengalensis	17	41	21	8	1.68	2	53	11	0	2.82
S. anaethetus	56	302	12	12	7.38	132	124	40	12	13.17
S.hirundo	12	16	12	0	0.77	6	7	12	0	1.06
S.repressa	32	6	0	32	1.35	0	2	1	0	0.12
Larus genei	206	456	511	89	24.41	113	20	31	40	8.72
L. ridibundus	8	234	165	67	9.16	297	34	24	6	15.44
L. fuscus	156	576	642	32	24.41	412	51	65	17	23.32

Table 4. Contd

L. argentatus	102	86	148	4	5.57	3	5	11	2	0.89
Dromas ardeola	13	12	0	2	0.52	4	2	0	4	0.42
Caldris minuta	11	4	0	0	0.29	0	3	2	0	0.21
Numenius arquata	14	12	31	0	1.29	5	2	3	1	0.47
N. phaepus	106	24	42	3	3.38	5	6	8	2	0.90
Limnicolla falcinellus	0	11	13	0	0.47	3	2	0	0	0.21
Ch. Alexandrines	0	11	0	0	0.21	0	0	0	0	0.00
Tringa tetanus	13	18	23	1	1.06	6	10	5	7	0.20
R. avosetta	12	21	15	4	1.00	8	6	9	2	1.06
H. ostralegus	3	4	6	8	0.40	2	3	5	8	0.77
Monthly waterbirds Numbers*	835 (16.15%)	2179 (42.14%)	1717 (32.21%)	512 (9.90%)	100	1232 (52.71%)	682 (29.18%)	289 (12.36%)	134 (5.73%)	100
Sum of four month			5243		-			2380		-
Monthly waterbirds species total	21	22	18	18	-	19	21	17	17	-
Waterbird population density	0.55	1.45	1.14	0.34	-	0.82	0.46	0.20	0.09	-
Average density		0.87						0.39		

Counted was at low tide and the area of the island was about 1500 ha.

had been bred on western edge of the island (Figure 4).

Species and populations of birds on the Nedelghar Island

Fourteen species of waterbirds were identified during study month. Total number of waterbirds were 1183 in 2003 and reduced to 918 individuals in 2012, (reduction was 22.40%). Average density of waterbirds population was 2.95 in 2003 and 2.29 in 2012. Reduction of the density was 22.35% (Table 5). There is not any official report of breeding birds in this island. None of waterbird's species had been bred in 2003 and 2012. Sea Turtles only breeds on it.

Population trend of waterbirds on the islands

Breeding population of the Terns species and Western Reef heron on the islands reduced from 4898 pairs in 2003 to 1645 pairs in 2012. Average reduction was 66.41% (Table 6), but the breeding population of Crab Plover increased from 1650 pairs in 2003 to 11701 pairs in 2012. The main breeding population of this species had been bred on the Dara Island (10500 pairs, Table 2). Breeding population of this species became about 7 fold in 2012. Total count method detected a total of 22100 bird individuals in 2003 and 18360 individuals in 2012 that belong to 37 species. Comparing these two numbers, it shows that reduction was 16.92% in waterbird's population in 2012 (Table 7). Eight species had been bred on the islands in 2003, and five species in 2012, reduction was 37.5%. Generally, breeding pairs of seven species were reduced and only one species increased. Total numbers of waterbirds were 22100 individuals in 2003 and reduced to 18360 individuals in 2012 and reduction was 16.92% (Table 7).

Diversity is a major aspect of species structure in avian community. Ecological Methodology Analysis Software (Version 6) by (Krebs, 2001) was used to determine and compare the diversity of waterbirds in the study area in 2003 and 2012. The result shows that waterbirds have the considerable species diversity, richness (37 especies) and evenness. All diversity indexes were lower in 2012 than in 2003 (Table 8). Similarity of breeding population of waterbirds has been showed in Table 9 and Figure 6. The most similarity was between Ghabre Nakhoda and Dara in August 2012, (94.80% Table 9). Least similarity was between Ghabre Nakhoda and Boneh in 2003 and 2012(11.27%, Table 9). There was not any similarity between breeding species on Nadelghar and other three islands in August 2003 and 2012, because there was not breeding species in Nedelghar in 2003 and 2012. The non-breeding species of waterbirds on four islands were similar (P_{value} = 5%) together (99.97%) (Figure 6), but there was 16.92% reduction of waterbirds populaton (except Crab Plover, An increase of Crab Plover occurred throughout the islands, Table 3) in 2012, (Table 7). Also the biodiversity indexes of the waterbirds were more in 2003 than in 2012 (Table 8).

DISCUSSION

Over 100 bird species occur in Khor Mosa (Behrouzi-Rad, 2008; Scott, 1995), of these, about 90% are waterbirds, of these more than 30% were present in study area

Table 5. Waterbirds of 14 species recorded at Nedelghar (area was 100 hectare)Island on May, August, November and December in 2003 and 2012.

Species	Nedelghar 2003					Nedelghar 2012				
	15th May	20th August	15th November	20th December	%	10th May	2sec August	6th November	12th December	%
Larus genei	113	16	12	112	21.38	112	18	121	13	28.75
L.ridibundus	12	3	1	8	2.02	0	1	3	3	0.76
L. canus	123	112	123	114	39.89	31	111	19	115	3.06
L.fuscus	118	113	31	11	23.07	117	17	112	11	27.99
Tringa totanus	1	0	0	2	0.25	1	0	0	3	0.43
Tringa stegnatilis	0	1	2	6	0.76	3	4	1	0	0.86
Tringa nebolaria	3	3	4	1	0.92	0	11	0	4	1.63
Egrtta gularis	4	5	2	0	0.92	3	1	2	0	0.65
Egretta alba	1	0	1	0	0.16	1	0	0	0	0.10
Charadrius dubius	3	4	0	11	1.52	0	0	23	11	3.70
Ch. Temminkii	12	6	15	21	4.56	5	7	11	3	2.83
Ch.minuta	6	0	3	11	1.70	0	2	1	0	0.32
Numenius arquata	5	1	3	4	1.09	7	1	0	1	0.98
Numanius phaepus	6	2	0	12	1.69	1	0	5	2	0.87
Monthly waterbirds numbers total*	407 (34.40%)	266 (22.48%)	197 (16.65%)	313 (26.45%)	100	281 (30.61%)	173 (18.84%)	298 (32.46%)	166 (18.08%)	100
Sum of four month		1183			-			918		-
Waterbird population density	4.06	2.66	1.96	3.13		2.8	1.73	2.98	1.66	
Monthly waterbirds species total	12	11	10	12		9	10	10	10	
Average density		2.95						2.29		

Table 6. Variation of breeding pairs of waterbirds on four islands in 2003 and 2012.

species	2003	2012	Variable	Trend	Average reduction
Lesser crested Tern	2681	550	79.48%	Reduction	
Swift Tern	136	54	60.29%	Reduction	
Bridled Tern	1874	1011	46.05%	Reduction	
White Cheeked Tern	10	0	100%	Reduction	
Caspian Tern	137	0	100%	Reduction	66.41%
Western Reef Heron	58	30	48.27	Reduction	
Little Egret	2	0	100%	Reduction	
Total nests	4898	1645	66.41%	Reduction	
Crab plover	1650	11701	Increased 7 fold	increased	
Number of. species	8	5	37.5%	Reduction	37.5%

(Tables 1 to 4). Besides terns, which breed in summer, several other species of waterbirds use the islands for breeding, notably Crab plover *Dromas ardeola* and Western Reef Heron *Egretta gularis*. Bridled Tern, Lesser Crested Tern, Swift Tern and Crab Plover were dominant breeders in the islands in 2003 and 2012, (Table 2). The breeding population of terns reduced, but the breeding population of Crab Plover increased in 2012. All breeder species declined from 2003 to 2012, (4898 to 1645 pairs, (Table 6), except Crab plover increased from 1650 to 11701 pairs) the fluctuation depends on security and local environment factors of the study area. Dominant species (non-breeder) during study months were *larus* sp (*Laris genei, larus ridibundus* and *Larus fuscus*) in islands, but population of them declined from 2780 individuals in 2003 to 2001 individuals in 2012 (Table 3). The main reason of this reduction is haunts of fishermen and local environment factors on the islands. Total population (non-breeding) 22100 reduced to 18360 individuals (reduction was 16.92%). Comparing the similarity measure

Table 7. Variation of waterbird's population (non-breeding) on islands in 2003 and 2012.

Place	2003					2012				
	May	August	November	December	Total	May	August	November	December	Total
Nedelghar	407	266	197	313	1183	281	173	298	166	918
Boneh	835	2179	1717	512	5243	1242	691	303	144	2380
Dara*	654	3989	1452	988	7083	2807	3564	883	1159	8413
G. Nakhoda	1421	5656	536	978	8591	1088	4311	534	976	6909
Total	3317	12090	3902	2791	22100	5191	8730	2004	2435	18360 (16.92%) Reduction

Table 8. Species diversity, richness and evenness in 2003 and 2012 in the study area.

Diversity index	2003	2012
Dominance_D	0.413	0.414
Simpson_1-D	0.786	0.585
Shannon_H	1.952	1.341
Evenness_e^H/S	0.406	0.261
Brillouin	1.912	1.308
Menhinick	0.583	0.512
Margalef	2.527	2.159
No. species	21	22
Total	22100	18360

Table 9. Similarity of breeding waterbird's population in 2003 and 2012.

Place		Ghabre	Nakhoda	Dara	Boneh		
		20th August	3th August	20th August	3th August	20th August	3th August
		2003	2012	2003	2012	2003	2012
G. Nakhoda	20th August 2003	100					
	3th August 2012	38.64	100				
Dara	20th August 2003	22	25.51	100			
	3th August 2012	42.56	94.8	20.37	100		
Boneh	20th August 2003	60.66	11.27	44.09	11.43	100	
	3th August 2012	52.74	11.27	49.04	11.43	92.09	100
Nedelgar	2003 and 2012	No breeding	No breeding	No breeding	No breeding	No breeding	No breeding

in Table 9 shows there is some difference between breeder species (8 species in 2003 and five species in 2012) and breeding population of waterbirds (4898 to 1645 pairs) in August 2003 and 2012. The Khor Mosa complex (Channels, islands, beaches, mudflats and sand hills) is the most important habitat for waterbirds in the Persian Gulf. For this reason, Khore Mosa complex was suggested for classification as sensitive habitat for breeding waterbirds, (Behrouzi-Rad, 2008), 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. Poaching is practiced particularly

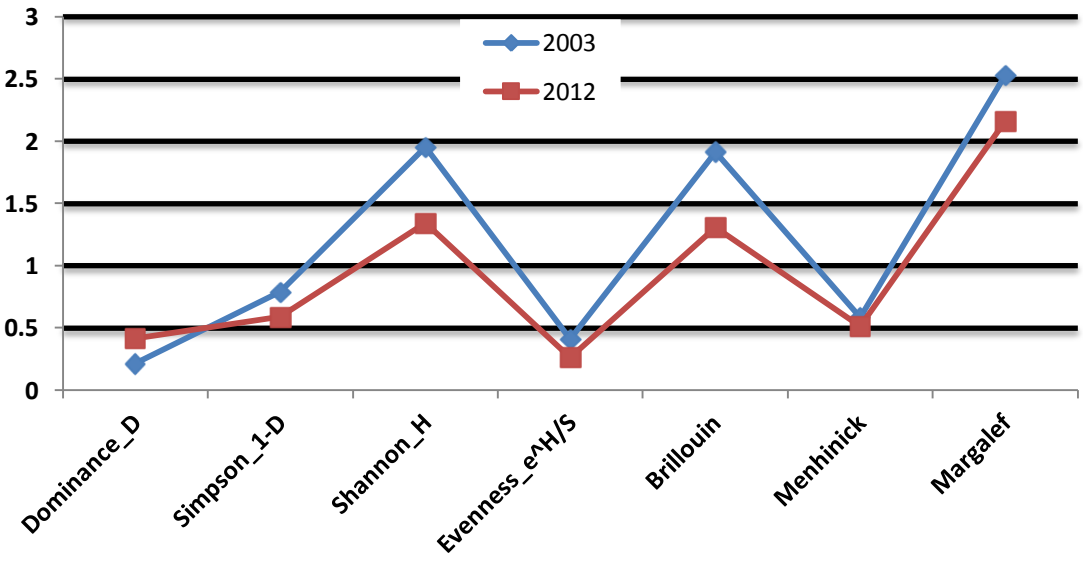

Figure 6. Measures of heterogeneity (95% confidence limits) birds in 2003 and 20012 in study area in non-breeding population.

on the islands. Oil pollution has been reported on the beaches around Bandar Mahshar in the southeast (Pandam, 2003; Behrouzi-Rad, 2013). The breeding success of the species is sensitive to food availability, predator presence, and human disturbance and oil pollutions in Khor Mosa, for these reasons Khore Mosa complex need to be protected during breeding season.

Conclusion

From this monitoring study, several conclusions can be made: This approach, of utilizing several methods to gather observations, provided enough records to monitor the Khore Mosa complex waterbirds population on islands. Considerable variation was noted in the number of breeding pairs from 2003 to 2012 (4898 to 1645 pairs).

Identification of essential roosting and nesting habitat required for sustaining seabird populations in a given region of conservation is needed to be given concern. Conservation problems and threats faced by seabirds in the region have been discussed elsewhere (Scott, 2007 and 2008; Evan, 1994; Tuck, 1974; Basson et al., 1977), but briefly these are included in offshore pollution, commercial exploitation of prey on which seabirds feed, incidental take, human disturbance, habitat reduction, and releasing waste water in water bodies. Seabird conservation is mostly a matter of island conservation.

Waterbird biology is useful indicators of environmental quality. Protection, management, and conservation of colonial waterbirds and seabirds can help conserve the broader landscape in which they occur. Wintering and other non-nesting habitats are critical to the long-term conservation of seabirds and colonial waterbirds.

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REFERENCES

Almarez P, Amat JA (2004). Multi-Annual spatial and numeric dynamics of The White-headed Duck *Oxyura leucocephala* in Southern Europe, Seasonality, density-dependence and climatic variability. J. Anim. Ecol. 73:1013-1023.

Basson PW, Burchard JE, Hardy JT, Price ART (1977). Biotops of the Western Arabian (Perian) Gulf. published by the Aramco Dep. of Loss Prevention and Environment Affairs, Saudi Arabia pp. 240-284.

Behrouzi-Rad B (2008). Sensitive Habitat of Waterbirds of Persian Gulf (In Farsi), Published by Dep. of Environment of Iran, pp. 160-261.

Behrouzi-Rad B, Tayfeh FH (2008). Nest Count of Western Reef Heron and four Sterna Species on Nakhiloo Island in the Persian Gulf from 2005-2007, Podoces 3 (1-2):45-52.

Behrouzi-Rad B (2013). Breeding species of Waterbirds on 10 Islands of Persian Gulf in 2009. Octa J. Environ. Res. 1(1):52-64.

Behrouzi-Rad B (2013). Waterbirds Population, Species Diversity and Similarity Fluctuation in Relation to Water Pollution in Zangi and Ahmadi Coastal Wetlands In Khore Mosa. Int. J. Mar. Sci. 3(39):311-318.

Burger J, Eichhorst B (2005). Heavy metals and selenium in Grebe eggs form Agasiz National Wildlife Refuge in northern Minnesota. Environ. Monit. Assess. 107:285-295.

Conway CJ (2005). Standardized North American marshbird monitoring protocols Wildlife Research Report, 2005-04. U.S. Geological Survey, Arizona Cooperative Fish and Wildlife Research Unit, Tucson, Arizona, USA

Enoder LD (2009). A review of the use of seabirds as indicator in fisheries and Ecosystem management. Fish Res. 95:6-13.

Evans MI (1994). Important Bird Area in the Middle East. Published by Birdlife International. pp. 65-158. www.amazon.com/Important-Middle-Birdlife- Conservation.. ./dp/0946888280.

Krebs J. Ch. (2001). Ecological Methodology Published by Harper & Row publishers. London. pp. 93-370.
Matsinos YG, Wolf WF (2003). an individual-oriented model for ecological risk Assessment of wading birds. Ecol. Model 170:471-478.
Miller MR, Beam J, Connely DP (1998). Dabbling duck harvest dynamics in the Central Valley of California–implication for recruitment. In: Weller M.W., (ed.) Water fowl in winter. University of Minnes ota Press, Minneapolis, MN. pp. 553-569.
Pandam Consulting Engineers (2003). Shadegan wetland Management Project. Report One, The Natural Environment of the Shadegan Wetland Ecosystem. (Chapter 7), Fauna. pp. 109-165.
Redon MA, Green AJ, Aguilera E, Almarez P (2008). Status, distribution and Log-term changes in the waterbirds community wintering in Donana southwest Spain. Biol. Conserv. 141:1371-1388.
Scott DA (1995). A Directory of Wetlands in the Middle East, published by IUCN, Switzerland, pp. 43-221. www.wetlands.org/LinkClick.aspx?fileticket =qpdnMu7JXYg%3D&tabid=56
Scott DA (2007). A Review of the Status of the Breeding Waterbirds in Iran in the 1970s. Podoces 2(1):1-21.
Scott, D. A., (2008). Rare birds in Iran in the late 1960s and 1970s. Podoces Vol 3, **1/**2: 1-30. www.osme.org/tripreports/PODOCES%203- % 20 rare%20.
Tuck GS (1974). Seabirds of the Persian Gulf (The Gulf) and Gulf of Oman, A Survey (1958–1973).Sea Swallow 23:7–21 Wetland International., 2007, The Asian Waterbird Census, Development Strategy 2007-2015, Wetland International, Kuala Lampur, Malaysia. p. 29)