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Research Article

DIVERSITY AND RICHNESS OF *STERNA* SPECIES IN THE MARINE NATIONAL PARK (MOND), PERSIAN GULF, IRAN

Samane Tahmasebi[1], Farangis Ghassemi[1] and Farhad Hosseini Tayefeh[2]
[1]*Department of Biology, Jahrom Branch, Islamic Azad University, Jahrom, Iran*
[2]*Department of the Environment (DOE), Bushehr, Iran*
**Author for Correspondence*

ABSTRACT
Wetlands by providing specific environmental conditions and having a rich source of genetic resources are important agents in the protection of biodiversity. For this purpose, present study was conducted in the Marine National Park (Mond) in Golf Persian, southern of Iran, with an area of about 46,000 hectares in January and September 2014. Research region is divided into 4 sites such as 1) Tahmadon and Harra forests, 2) Mond river inlet, 3) Khan Island, and 4) Khor bay. Navigation area, species identification and their enumeration were carried in collaboration with Department of Environment of Bushehr personnel. Bird counting was carried with total count method and nest count method. Laying area was determined with a cloth meter and GPS, and then estimation of the average number of nests per square meter was done. Birds were visited by using binoculars and telescopes and were photographed. Then Tern species were identified according to their morphological characters and behavior using taxonomic keys. The data were analyzed using SPSS version 20 and graphs were plotted using Excel software. Diversity and richness of the identified species were determined and relationship between sampling stations and bird species were analyzed using chi-square test in $P<0.01$. A total 78,771 individuals of Terns belonging to 7 *Sterna* genus were observed. *Sterna bengalensis* with 42,315 individuals recorded with the highest population (53.7%) and *Sterna albifrons* with 4 individuals was the lowest of them. The highest and lowest population density and diversity was seen respectively in Hara forests and Khan bay. According to the obtained findings, research area is a suitable habitat for Terns and the protection of this area is necessary for bird conservation.

Keywords: *Wetlands, Diversity, Tern, Habitat, Conservation*

INTRODUCTION
Biological diversity is one of the characteristics of each ecosystem, so it is used in the evaluation of habitats (Ajtahadi *et al.,* 2010). Bird especially coastal type is good markers for quality and threats of the wetlands and they are important in health of their ecosystems, so faunastic study for conservation of them is necessary. Although the large parts of Iran is extremely dry, there are several wetland systems are in north and south of it. It has many known special regions for overwintering of birds is a important region in Middle East (Majnonian, 2000). 517 species of birds belongs to 79 families and 19 orders have been recorded in Iran (Amini and Hoon, 2005) and 323 of them migrate from Paleartic, oriental regions and elsewhere (Scott, 2007). Coastal area in the south of Iran with tropical temperature has varied avifauna and Persian Gulf especially northern part is suitable habitat for many waterbird species (Wei *et al.,* 2009). Mond National park with 46000 hr expanse located in Bushehr province is the majority of important wetlands in southern of Iran and was protected from 1976 by Department of Environment of Iran (Mostafavy *et al.,* 2007). This region is divided to land and aquatic ecosystems and has sand soils, islands and rich flora (more than 140 plant spices) and fauna (more than 242 animal spices). Their coastline is covered with mangroves (Mehrabian *et al.,* 2008) and contains diverse habitats, so attracts many different species of animals (Mostafavy *et al.,* 2007).
In recent years, in order to predict the damage inflicted on the environment as pollutions, natural disasters and so on, bird's identification is important to assess the quality of coastal ecosystems. Coastal zone as environmental lifeline for migratory birds to feeding, resting, wintering and breeding is a valuable ecosystem (Behrozi, 2009). So the protection of these sites need to the international cooperation.

The waterbirds in Iran were studied (Behrouzi *et al.*, 2004; Shariat and Behrouzi, 2009). Although Caspian Sea shores are important wintering area for waterbirds in the Middle-East (Mansori 1984; Amini and Hoon, 2005) but some species of waterbirds were recorded on the Persian Gulf (Behrouzi-Rad and Tayfeh 2008; Jamadi and Darvishi, 2008; Tayefeh *et al.*, 2011).
Terns (genus *Sterna*) belong to family Sternidae and order Charadriiformes. Although most species of Thern live in the tropics and subtropics, but they have a world-wide distribution (Voisin and Voisin, 2011). There are 44 species worldwide and 14 known species in Iran (Mansory, 2000). Tayefeh *et al.*, (2011) recorded *Sterna* species in this region during 2003 to 2010, so this place is as the site for their mating and increase breeding success. This survey was carried out to determine the abundance and diversity of Terns in Mond Islands.

MATERIALS AND METHODS

Research Area

Marine National Park Mond (27° 15′to 28° 45′N and 51°15′to 51°35 E) with 46,000 ha is in Bushehr province (southern of Iran) (Figure 1). This region is protected by Department of the Environment of Bushehr and have high diversity of animal specially birds. Present survey was carried in January and September 2014 during in one week. The research region was divided to 4 sites as follow:
1: Tahmadon and Harra forests (27° 15′to 28° 45′N and 51°15′to 51°35 E)
2: Mond river inlet (28° 09′ N and 52°12′ E)
3: Khan Island (27°29'N, 51°16'E,)
4: Khan bay (28° 04′ N and 51°28′ E)

Figure 1: Map of research region

Methods

All sites were gone by foot and car and bird's nests were examined and visited the birds by direct observation, binoculars, and telescope. Then they were counted by total count method and using nest count method in large colonies of birds. Laying area was determinate with a cloth meter and GPS, and then estimated the average number of nests per square meter. The mean number of nests in colonies multiplied by total area and total number of nests in each separation was achieved. Birds were visited by using binoculars and telescopes and photographed. Then Terns species were identified according to their morphological characters and behavior by using Handbook of the Iranian Birds (Mansori, 2013). The data were analyzed using SPSS version 20, diversity and richness of the identified species were determined and relationship between sampling stations and bird species were analyzed using chi-square test in $P<0.01$. In this study, 78,771 pieces of bird belonging to 7 species of *Sterna* genus were

Numbers of photographs were taken from all of birds in every site by using a Canon camera (500mm f4 with Tele-Zoom lens) in collaboration with Department of Environmental of Bushehr (DOE). Geographical coordinates were measured by GPS and determined on digital map (scale map: 1:250.000). Bird counting was carried out in all selected sites during one week simultaneously and some birds were captured on nights when the birds could not fly.

Sterna genus was identificated according to morphological features (Mansori, 2000) and experiences of DOE personnel. Obtained data was analyzed by ANOVA test in significance level ($p<0.01$) and the relationship between sampling stations and bird species were tested by using the chi-square test.

RESULTS AND DISCUSSION

A total of 78771 Terns belong to 7 spices of *Sterna* genus that were seen in summer (99%) and winter count (1%). Except *S. fuscata* and *S. albifrons*, others were seen in both seasons (Table 2). The most of the population belong to *S. beagalensis* (53.7%) and the least was *S. albifrons* (Table 1). The highest population and diversity of terns were observed in Tahadon and Harra forests (85%) and the least was in the Mond river inlet (0.14%) (Table 3).

According to analyzed data, significant relation ($p<0.01$) was seen between the observed species and date of observation of them (table 2) and their habitat (table 3). *S. fuscata* and *S. albifrons* were not seen in winter and *S. albifrons* wasn't in any sampling site except Tahamadon.

Table 1: Density of *Sterna* species in Mond Park (Southern of Iran) in 2014

Tahmadon	Khan bay	Khan Island	Mond river inlet	September	January	Spices
0	0	0	0	-	0	***Sterna fuscata***
25500	4	30	0	25534		
8	110	23	8	-	149	***Sterna caspia***
50	78	92	12	232		
3	1	0	0	-	4	***Sterna bergii***
2850	35	7550	17	10452		
0	0		0	-	3	***Sterna beagalensis***
38700	35	3500	80	42315		
0	4	0	0	-	4	***Sterna repressa***
38	3	8	0	49		
10	0	0	0	-	10	***Sterna nilotica***
0	0	15	0	15		
0	0	0	0	-	0	***Sterna albifrons***
4	0	0	0	4		
67163	270	11218	117	78518	253	

Table 2: Seasonal distribution of *Sterna* species in Mond Park (Southern of Iran) in 2014

Total	Date		Spices
	September	January	
381	149	232	*Sterna caspia*
25534	25534	0	*Sterna fuscata*
10456	10452	4	*Sterna bergii*
42318	42315	3	*Sterna beagalensis*
4	4	0	*Sterna albifrons*
53	49	4	*Sterna repressa*
25	15	10	*Sterna nilotica*

Table 3: Distribution of *Sterna* species in Mond Park (Southern of Iran) in 2014

Total number	Station				Spices
	Khan bay	Mond river	Island Khan	Tahmadon Island	
381	101	20	202	58	*Sterna caspia*
25534	4	0	30	25500	*Sterna fuscata*
10456	36	17	7550	2853	*Sterna bergii*
42318	35	80	3503	38700	*Sterna beagalensis*
4	0	0	0	4	*Sterna albifrons*
53	7	0	8	38	*Sterna repressa*
25	0	0	15	10	*Sterna nilotica*

Discussion

Results of a winter and summer enumeration have significant difference (Table 2) and population of Terns related to date and site observation significantly ($P<0.01$). Obtained data referred to migration possibility. Due to seasonal observation of *S. caspia and S. nilotica,* probably these species were emigrant and occupant in this habitat.

In regard to bird density in the research region (Table 1) and the significant relation between diversity and population of birds in their habitats and date of their presence (Table 2), probably these spices are emigrant an spend winter in another site.

Recording four spices of Tern in Nakhiloo Island, small part of Golf Persian, by Behrouzi and Tayefeh (2008) and obtained results of this study (Table 1-3), showed that this region is suitable for breeding and wintering for emigrant waterbirds (Scott, 2007) and even permanent inhabitancy for species of Terns (Tayefeh *et al.*, 2011).

The large colonies were seen in Tahmadon (site 4) and smaller than in site 3 (Mond river). Although site 4 was the widest sampling station (more than 700 ha) but spatial environmental factors as presence two ecosystems, land and aquatic areas, the geographical isolation and being haunted is considered as a main factor for species richness (Whittaker and Fernández-Palacios, 2007). Food availability and climatic variations are the important for population size. So, warm climate in summer and moderate weather in winter are reasons for attracting thermophile waterbirds (Mansori, 2013). Also sand beaches or rocky areas support a variety of breeding. Although Terns have high diversity of food but the main prey of them is fish and shrimp that are abundant in this region. Also presence abundant mangroves (Harra forest) create safe nest for fish lying and the other hand, hide breeding sites of terns as access to them is difficult and colonies can be large and widely distributed. In addition low predation and disturbance of human (trapping of bird or fishing) and other animals also aid to their distribution (Votier *et al.*, 2004). Fortunately these region are protected, nevertheless all present birds need to be very well protected.

Despite of presence all explained factors, but they are affected by all of parameters that changed environmental condition and popular changes of species are indicators for the degree of changes (Amat

and Green, 2010). Thus, annual counting and comparing with previous results is necessary for protection of these birds.

Conclusion

Obtained results in this research showed that Terns with high population and diversity are in research study, and the most spices and highest population are seen in summer. The existence of these species indicates this region is appropriate for bird's diversity, so each pollution event, human disturbance and changes in ecosystem must be restricted. Serious protection of these habitats is very necessary for bird's conservation.

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