STATUS OF TERNS ON NAKHILOO ISLAND, PERSIAN GULF, WITH EMPHASIS ON LESSER CRESTED TERNS *THALASSEUS BENGALENSIS*

HAMED GHANAATIAN[1]*, ALIREZA SAFAHIEH[1], KEIVAN KABIRI[2] & AHMAD SAVARI[1]

[1]*Marine Biology Department, Marine Science and Oceanography Faculty, Khorramshahr University of Marine Science and Technology (KMSU), Khorramshahr, Khuzestan, Iran *(hamed.ghanaatian@gmail.com)*
[2]*Oceanic Data Management & Remote Sensing Department, Iranian National Institute for Oceanography and Atmospheric Science (INIOAS), Tehran, Iran*

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ABSTRACT

GHANAATIAN, H., SAFAHIEH, A., KABIRI, K. & SAVARI, A. 2024. Status of terns on Nakhiloo Island, Persian Gulf, with emphasis on Lesser Crested Terns *Thalasseus bengalensis*. *Marine Ornithology* 52: 373–377. http://doi.org/to_come

Lesser Crested Tern *Thalasseus bengalensis* (LCT) is the second most abundant tern in the Persian Gulf region. Stratified random sampling was used to census the colonies on Nakhiloo Island, Iran. On average, 9.45 eggs, 2.2 early chicks, and 1.1 empty nests with material were counted in each 1×1 m plot in late June 2022. Analysis of those results indicated the breeding population of LCT on Nakhiloo Island to be 31 786 pairs. Other terns and plovers were also present in five of seven LCT subcolonies. Variable sea-surface temperatures (SST) with a slight upward trend and a decrease in chlorophyll *a* (Chl *a*) were evident in waters surrounding the island during 2002–2021, but it is unknown whether the tern population has or will be affected by changes in the food web caused by these evident changing oceanographic conditions. Results show that Nakhiloo Island is a hotspot for tern colonies in the Persian Gulf. Anthropogenic factors, including climate change, will threaten its future suitability, requiring more specific conservation management than currently practiced.

Key words: Bridled Tern, chick-rearing habitat, global warming, Lesser Crested Tern, migratory seabirds, Greater Crested Tern, sympatric breeding species

INTRODUCTION

The Persian Gulf is a subtropical region of the Indian Ocean with many flat islands that are inhabited by humans (Ghanaatian 2011, Ghanaatian *et al.* 2021). These islands are very warm during the summer (Nandkeolyar *et al.* 2013) and provide breeding habitat for several seabird species (Tayefeh *et al.* 2011). Nakhiloo Island, a small and remote island off the coast of Dayyer county in Iran's Bushehr province, is located in Dayyer-Nakhiloo National Marine Park (DNNMP; Fig. 1). This park is a hotspot for some terns, including large numbers of Lesser Crested Tern *Thalasseus bengalensis* (LCT). After Bridled Tern *Onychoprion anaethetus* (BT), LCT is the second most abundant species in the Persian Gulf tern community and remains within the Indian Ocean region year-round (Tayefeh *et al.* 2011, 2012; Ghanaatian *et al.* 2023b).

Urbanization and other human interferences, such as industrial pollution and military activities, have caused the loss of much reproductive habitat for terns in the Persian Gulf. Habitat quality will likely also be affected by long-term changes in sea-surface temperature (SST) and primary production (Lawrence *et al.* 2015, Ghanaatian *et al.* 2023a). Few studies, however, have assessed the status of terns in the region. The goal of the present study was to provide a breeding population census, record sympatric breeding species, and report on the status of colonies, nests, eggs, and chicks to establish baseline data to inform the protection and management of LCTs in the Persian Gulf.

METHODS

Study area and counts

We conducted surveys on 25–26 June 2022 at Nakhiloo Island, which is located in DNNMP in the south of Bushehr province, Iran (Fig. 1). The island (27.823°N, 051.472°E) is ~6 km^2 in area, and thus small enough that we could survey it entirely. This time of year was chosen because all species of terns that breed on the island have arrived by late June, leading to better accuracy for the census.

LCT breeding colonies tend to be on bare ground with a slight slope. When nesting, LCTs are usually interspersed with Greater

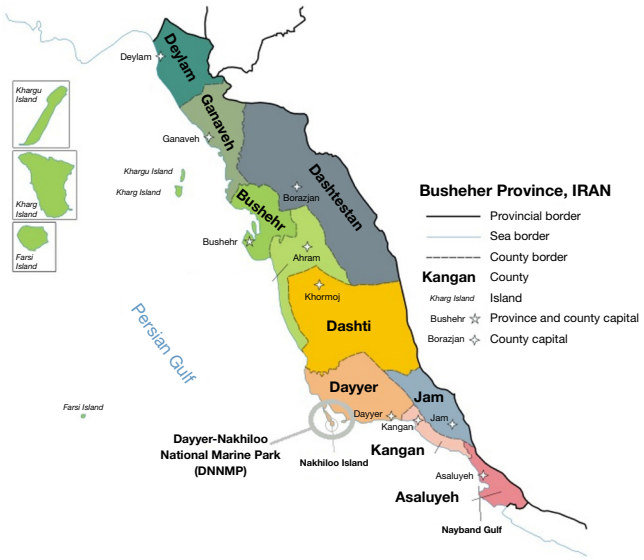

Fig. 1. Map of Bushehr province, Iran, in the northern Persian Gulf showing the counties and the locations of Dayyer-Nakhiloo National Marine Park and Nakhiloo Island. Image credit: modified from Wikipedia.

Crested Terns *Thalasseus bergii* (GCT, also known as Swift Tern), which are similar in appearance (Ghanaatian *et al*. 2021) but can easily be differentiated: GCTs are ~25%–45% bigger and have yellow beaks while LCTs are smaller and have darker, orange-tinted beaks (Ghanaatian *et al*. 2021). GCT eggs are also larger than LCT eggs. In order to confirm and differentiate nests for LCT and GCT, the length and width of eggs were measured in place using calipers.

Seven subcolonies of LCTs were present on the island, each clearly separated from the others (Fig. 2). The size of each subcolony was estimated using Global Positioning System (GPS; Garmin eTtrex 10; Olathe, USA; Table 1). We used stratified random sampling to count the terns, as per Walsh *et al.* (1995) and Gregory *et al.* (2004). We established 1×1-m plots (Fig. 3A, 3D) within which eggs, early chicks, and empty nests were counted. In some plots, photos were taken. The number of walking chicks and juveniles was estimated using three-count repetitions.

LCT demographic analysis

The percent prevalence of eggs, early chicks, walking chicks, and juveniles was estimated for each subcolony. The total number of parents present on the island was estimated from the relative proportions of clutch sizes (1, 2, or 3 eggs). All statistical analysis and charts were created using Microsoft Excel software, version 14.0.6023.1000 (32-bit).

Trend study for SST and Chl *a*

Monthly average SST and chlorophyll *a* (Chl *a*) remote-sensing data were plotted from August 2002 to November 2021 within LCT foraging range. Daytime SST and ocean chlorophyll-type (OCx) Chl *a* data were extracted for 9-km^2 pixels using moderate-resolution imaging spectroradiometer (MODIS) sensor images from the USA's National Aeronautics and Space Administration website (NASA Ocean Biology Processing Group 2021). We used ArcMap v.10.8 (Environmental Systems Research Institute; Redlands, USA) to extract data.

RESULTS

Subcolony composition

The LCT population on Nakhiloo Island is concentrated in its southern portion (Fig. 2). Five of the seven subcolonies contained nests of seabird species besides LCT (Table 1). Subcolony number 3 contained

Fig. 2. Satellite image showing the boundaries of the Lesser Crested Tern *Thalasseus bengalensis* subcolonies on Nakhiloo Island, Iran, where counts were taken in June 2022. See Table 1 for the distribution of species among sites.

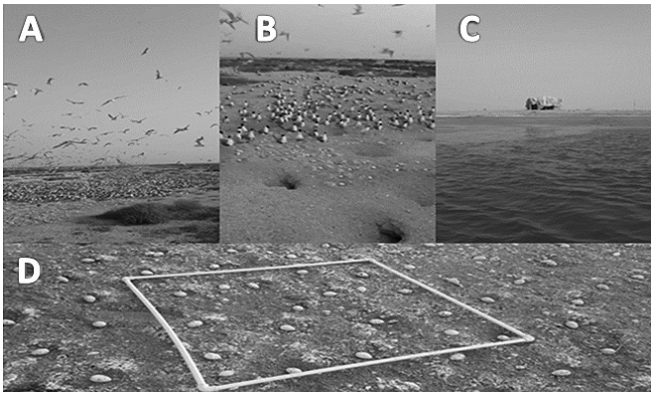

Fig. 3. A) Lesser Crested Tern *Thalasseus bengalensis* subcolony 2 at Nakhiloo Island, Iran, in June 2022. B) Lesser Crested Terns and Greater Crested Terns *Thalasseus bergii* nesting on ground overlying Crab-plover *Dromas ardeola* tunnels. C) A fishermen's gazebo on the island's eastern shoreline. D) Example of a 1×1-m plot used in sampling.

TABLE 1
Species composition of the seven Lesser Crested Tern *Thalasseus bengalensis* subcolonies on Nakhiloo Island, Iran, censused in June 2022

Colony number	Area (m^2)	Lesser Crested Tern *Thalasseus bengalensis*	Greater Crested Tern *Thalasseus bergii*	Bridled Tern *Onychoprion anaethetus*	Sooty Tern *Onychoprion fuscatus*	Crab-plover *Dromas ardeola*
1	75	☑	☑	-	-	-
2	40	☑	-	-	-	-
3	2500	☑	☑	☑	☑	☑
4	5	☑	-	-	-	☑
5	20	☑	-	-	-	-
6	25	☑	☑	-	-	-
7	15	☑	☑	-	-	-

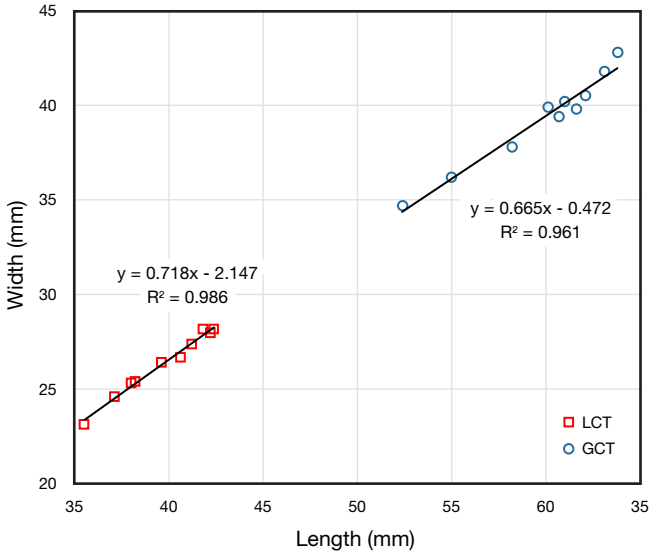

Fig. 4. Regression of the lengths and widths of Lesser Crested Tern *Thalasseus bengalensis* (squares) and Greater Crested Tern *Thalasseus b*ergii (circles) eggs on Nakhiloo Island, Iran, in June 2022.

nests of LCT, GCT, BT, Sooty Tern *Onychoprion fuscatus* (ST), and Crab-plover *Dromas ardeola* (CP). CPs are known to dig deep tunnels in sand dunes (Tayefeh *et al.* 2013b), and in some cases, beneath tern nests (Fig. 3B). We observed that CPs have an interesting chick-rearing strategy: they lay their eggs and rear the chicks in tunnels and train the juveniles for nocturnal foraging, which is unusual among terns. Subcolonies 1, 6, and 7, contained only LCT and GCT nests. Subcolonies 2 and 5 were composed of only LCT nests.

LCT and GCT have similar nests in shape and building material. In both species, parents take turns incubating the egg(s) while the other forages. The birds flushed when we approached the nests and while the brooding parents were away, the nests could be distinguished by egg size (Fig. 4). We did not measure the eggs of other species.

On the beach at the eastern end of the island, we observed a ~50 m^2 gazebo (Fig. 3C) belonging to the local fishermen, who use it for resting.

Tern abundance

Among the 40 plots that we assessed, 79% of nests had one egg, 8% had two eggs, 3% had three eggs, and approximately 10% of nests were empty; we categorized these latter nests as "inactive" (Fig. 5). Of active nests containing eggs, clutches of 1, 2 and 3 eggs contributed 87.6%, 8.9%, and 3.5%, respectively, to the relative proportions. Applying these proportions to empty nests allowed us to estimate the number of walking chicks (Table 2, Fig. 6). Our surveys indicated that 19% of eggs in active nests had hatched. In another triplicate sampling, 10% of walking chicks became juvenile or early juvenile birds. Considering all evidence, the number of pairs of actively breeding adult LCTs on the island was estimated to be 31 786 pairs (Table 2).

TABLE 2
Census of the Lesser Crested Tern *Thalasseus bengalensis* population on Nakhiloo Island, Iran, in June 2022

	Total count
Eggs	24 790
Early chicks	5896
Walking chicks	3076
Juveniles	342
Eggs, chicks and juveniles	34 104
Breeding pairs	31 786

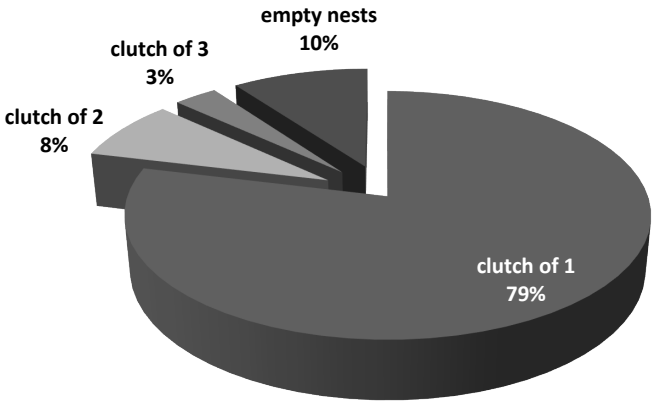

Fig. 5. Relative proportions by clutch size in the Lesser Crested Tern *Thalasseus bengalensis* nests on Nakhiloo Island, Iran, censused in June 2022.

Ocean climate change

SST and Chl *a* data indicated increasing and decreasing trends, respectively, during August 2002 to November 2021 (Figs. 7, 8).

DISCUSSION

Biological and ecological aspects of Nakhiloo Island, such as breeding population, proper slope of nesting ground, and absence of predators, indicated favorable breeding habitat for LCT and other species. Approximately 20% of the global population of CP breed on Nakhiloo Island (Tayefeh *et al.* 2011, 2013b) and marine turtles visit Nakhiloo Island to lay eggs (Nasiri *et al.* 2022). Therefore, the island deserves designation as a Marine Protected Area (MPA) by Iran's Department of the Environment (DoE; Kelleher 1999).

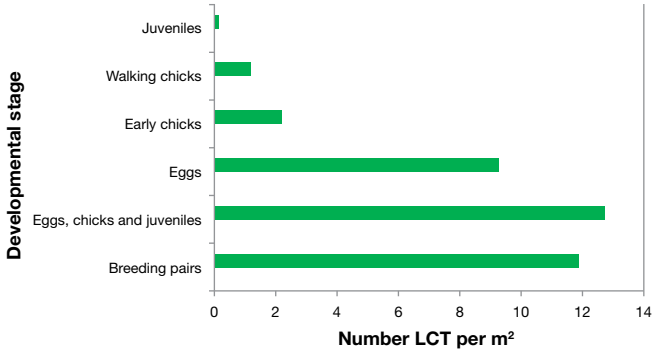

Fig. 6. Average numbers of Lesser Crested Tern *Thalasseus bengalensis*, categorized by developmental stage, for each square meter of nesting area on Nakhiloo Island, Iran, in late June 2022.

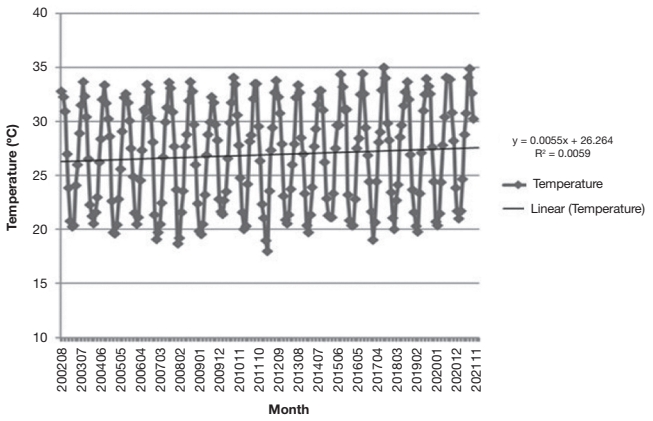

Fig. 7. Trend for sea-surface temperature (°C) around Nakhiloo Island, Iran, from August 2002 to November 2021. Data was extracted from the Ocean Biology Distributed Active Archive Center (NASA Ocean Biology Processing Group 2021).

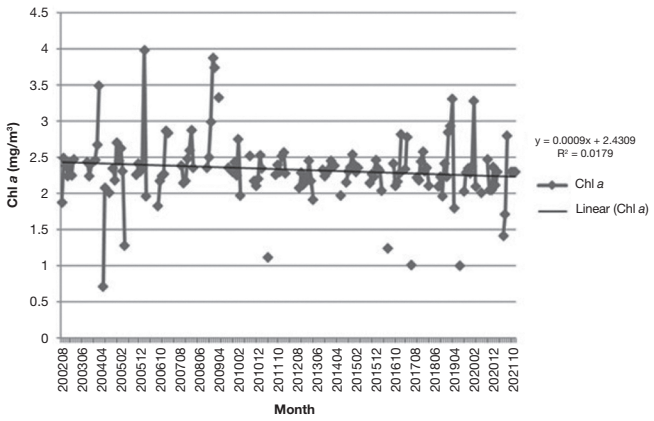

Fig. 8. Trend for chlorophyll *a* (Chl *a*, mg/m^3) around Nakhiloo Island, Iran, for August 2002 to November 2021. Data was extracted from the Ocean Biology Distributed Active Archive Center (NASA Ocean Biology Processing Group 2021).

Compared to previous studies, our census of the LCT population indicated a higher population size. The breeding population in 2013 was 27 000–28 000 pairs among seven islands in the Persian Gulf (24 000 pairs on Nakhiloo Island; Tayefeh *et al.* 2013a). Some anomalies exist in annual environmental reports (Iranian DoE unpubl. data), but in 2017–2021, the number of breeding pairs was 30 000–34 000 (Ghanaatian *et al.* 2021). In the current study, we estimated 31 786 LCT breeding pairs, but we acknowledge that such a figure is likely overly precise. Differences in sampling methods likely caused some of the variability in results. Based on available data of previous similar studies (Tayefeh *et al.* 2011, 2012), we thought that considering clutch sizes and the relative proportions of eggs, early chicks, walking chicks, and juveniles as evidence of active nests provided a more accurate assessment of breeding population size.

Nearly 80% of nests on Nakhiloo Island contained at least one LCT egg, which indicates a robust population (Stutchbury & Morton 2022) and confirms the species' classification as Least Concern (BirdLife International 2023). However, to monitor the LCT population, a comprehensive plan must be formulated by regional environmental organizations or the governmental DoE for Nakhiloo and other islands of the Persian Gulf to derive a standard sampling method, including standardization of sampling frequency and duration (Gregory *et al.* 2004). In addition, variation in the timing of breeding in any given year must be considered in colony assessments, as phenology could well be changing due to the trends in ocean climate (Fiedler 2009). During recent decades, average monthly SST increased by more than 1.6 °C and average Chl *a* decreased ~0.3 mg/m^3 (Figs. 7, 8). Therefore, it is possible that the food web is changing, and the birds' response should be considered (Keogan *et al.* 2018).

Irresponsible and illegal fishing by trawling and purse seining, especially for sardine and anchovy (*Dussumieria acuta*, *Sardinella gibbosa*, *Thryssa* spp., etc.), has been prevalent in the northern Persian Gulf, especially from Nayband Gulf (Asaluyeh county) to the fishing ports of Kangan and Dayyer (including areas in the DNNMP; IFO 2021; Fig. 1). Greater control of fishing is needed, at least within DNNMP. Only 14 fishing boats have legal permission to catch sardine and anchovy in waters of Bushehr province during autumn and winter (IFO 2021), but purse seines are used illegally by local fishermen throughout the year. Bottom trawling occurs during ~45 days during the summer off Bushehr province (IFO 2021), but without adequate surveillance. These fisheries target likely prey of the terns (Ghanaatian *et al.* 2023a, 2024).

Irresponsible dumping of oil and plastic wastes also could be negative factors for LCTs. Some fishing boats and barges or cargo barges dump oil and plastic wastes into the sea (Richardson *et al.* 2015; Richards *et al.* 2021; Ghanaatian *et al.* 2023a, 2024). We recommend with others that fishery, environmental, port, and maritime organizations hold training courses on the hazards of marine pollution. Finally, the construction of gazebos or resorts on the eastern shore of the island caused much disturbance to nesting terns (Ghanaatian *et al.* 2024).

CONCLUSION

Nakhiloo Island is a breeding hotspot for LCT. A number of human activities may negatively affect LCTs and other tern species using the island and the region. Given the changing oceanographic climate and the growing threats to prey abundance and habitat, we should not be satisfied with the currently robust breeding populations. We need to pay serious attention toward improving management measures. International institutes and organizations like the UN can help with such initiatives in under-developed countries like Iran, especially those whose economies are under sanctions and who have less opportunity to spend sufficiently for protection of wildlife. Based on our study results, DNNMP can be a pilot site for comprehensive risk assessment of global warming on seabirds and MPA management. We strongly recommend that United Nations programmers consider a conservation plan and examine the effects of proper management on terns over a 10-year monitoring period at least. In that way, the effects of climate change and anthropogenic factors, such as overfishing, might be reduced.

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