



Breeding and a Phenological Shift in the White-Eyed Gull Larus Leucophthalmus in the Red Sea Islands of Egypt

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Abstract

The northern region of the Red Sea in Egypt contains a variety of bird species that are rare or exclusive to the Western Palearctic, therefore making it a key ornithological habitat. This study revealed survey data for the northern Red Sea Islands in 2023, all the way to Rocky Island, which is southeast of the Egyptian border, compared to the survey in 1998. The objective was to assess the status of breeding seabirds in the Egyptian Red Sea, identify obstacles, and formulate plans for conservation management. The observed species include the Brown Booby (*Sula leucogaster*), Eurasian Spoonbill (*Platalea leucorodia*), Sooty Gull (*Larus hemprichii*), White-eyed Gull (*L. leucophthalmus*), Caspian Tern (*Hydroprogne caspia*), White-cheeked Tern (*Sterna repressa*), Lesser Crested Tern (*Thalasseus bengalensis*), Greater Crested Tern (*T. bergii*), Bridled Tern (*Onychoprion anaethetus*), and Saunders's Tern (*Sternula saundersi*). The absence of human disturbance and the availability of food most likely influence the distribution of breeding seabirds in the Egyptian Red Sea. Most species breed throughout the spring or summer, however two species do so in the winter. Nesting birds experience greater stress throughout the summer due to the extreme temperatures. Seabirds face a significant threat from oil spills originating from offshore drilling platforms and contaminated bilge water discharged by vessels. In addition, the arrival of visitors and fisherman on islands can result in birds abandoning their nests. Visitors and fishermen should be prohibited from visiting islands during the mating season to protect nesting birds.

Keywords: Egyptian, Gull, Red Sea, seabirds & Tern

1. Introduction

Seabirds are highly threatened bird species, facing various risks both on land and in the sea. On land, they are affected by coastal development, changes in the availability and quality of their breeding and wintering habitats, and the colonization of both native and invasive species. In the ocean, they face dangers such as unintentional capture by fisheries (known as bycatch), decline in fish populations leading to reduced food availability, pollution from oil spills and chemical re-

leases, accumulation of marine debris, and congestion caused by maritime transportation, among other concerns [1]. Furthermore, climate change will introduce new threats to seabirds, including changes in the distribution of their prey and the degradation of their habitats.

Positively, there is a noticeable increase in seagull populations in Australia, Europe, and certain regions of North America. This is primarily due to the growing abundance of food as a result of human activities [2]. Jennings et al [3] and Goodman and Storer [4] compiled a comprehensive list of seabird species that reproduce on the islands of the Egyptian Red Sea. In addition, Frazier et al. [5] documented their observations made during the spring

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of 1982 along the Red Sea coast of Egypt, specifically focusing on breeding and migratory species. In a more recent study, Hoath et al. [6] examined the breeding patterns of birds on the islands located in the Gulf of Suez. Grieve and Millington [7] documented the presence of islands in the northern Red Sea. They also identified the species that were observed during breeding on the Red Sea Islands, as described in the published work.

Brown Boobies (*Sula leucogaster*) are a rare breeding species on islands in the Egyptian Red Sea. It is a common occurrence in the Gulf of Aqaba, but only happens sporadically in the Gulf of Suez. The specific subspecies found in Egypt is *Sula leucogaster plotus* [8, 9]. In the past, the species was discovered reproducing on Ashrafi, with a total of seven breeding pairs in the spring of 1983 [3]. They were also located on Geisum Island, where there were 46 breeding pairs in the spring of 1983 and 18 chicks in the autumn of 1984. Additionally, the species was observed on Umm El Heimat, with three pairs in the spring of 1983 and one chick in the autumn of 1984 [3, 5]. Prior to 1999, the species exhibited consistent breeding behavior on Geisum, Umm El Heimat, and Zabargad islands [7, 10]. Sooty Gulls exclusively reproduce on islands. The species is native to the northwestern Indian Ocean and its breeding is restricted to the east coast of Africa, the Red Sea, the Arabian Gulf, and the Gulf of Oman, located south of Pakistan [11]. Jennings et al [3] and Goodman & Storer [4] provided inventories of seabird populations that breed on the islands in the Egyptian Red Sea. Gezira Wadi Gemal is the sole island in the Egyptian Red Sea where the Sooty Gull nests [4, 7]. The White-eyed Gull is classified as Near-threatened on the IUCN Red List [12]. There is an expected decline in population over the next three generations, which is estimated to occur within a span of around 30 years. This decline is anticipated to be somewhat rapid and is attributed to many risks, including the introduction of new predators, oil spills, the harvesting of eggs and chicks, and disturbances. However, further investigation is necessary to comprehensively comprehend these alterations and build efficient preservation endeavors for vulnerable species like

the White-eyed Gull.

This study provides a comprehensive surveys of seabird breeding in the specified region, encompassing seabirds ranging from the Red Sea Islands to the Rocky Islands near Ras Banas. The timing of breeding and the frequency of mating were recorded. In order to ascertain changes in the breeding season and number of breeding pairs, a survey study in 2023 was compared with data released in the 1980s. In addition, we integrated biological and environmental data to uncover insights regarding the influence of climate change on the timing of breeding season and the frequency of mating. The objective of this study is to examine the extent to which global warming contributes to the observed change in the breeding timing of the White-eyed Gull. By concentrating on this particular species, we anticipate gaining a deeper understanding of the potential impacts of climate change on seabird populations in the Red Sea area. This study highlights the ongoing impacts of climate change on the number of seabirds, as different species adjust and relocate their habitats in response to increasing temperatures.

2. Materials and Methods

2.1. Survey Protocols

The surveys were done between April and August 2023 on Egyptian islands along the Red Sea Coast to evaluate the nesting time of seabirds. The islands that were visited, in chronological order from north to south, include Ras Matarma Island, Asharafi Islands, Tawila Island, El Hamra Island, Gysom Island, Gubal Islands, Umm El Humate Island, Big Gifton Island, Big Magawish Island, Wadi El Gemal Island, Siyal Island, Mahabis Island, Shawareet Island, Hamata Islands, Zabargad Island, and Rocky Island. Past journeys were utilized for the sake of time conservation, as documented by Habib [13, 14]. According to Bibby et al. [15], the trips to different regions of each colony were brief, typically lasting 5-15 minutes. The counts were conducted using the approach of total adult-only total count. Additionally, nest counts were conducted, with the counting units being nests that seemed to be occupied. The total number of nests at a certain loca-

tion was determined by adding up the number of nests that were occupied and the number of nests that were vacant but appeared to have been utilized throughout the breeding season [15]. The majority of behavioral observations were conducted utilizing binoculars, a telescope, and a Canon 7D camera at optimal vantage positions.

2.2. Description of the Red Sea Islands

The Al-Ashrafi Islands consist of three elongated islands along with a small number of rocky outcrops. The islands are situated at the coordinates of 27° 45' north latitude and 33° 42' east longitude, approximately 12 km off the western coast of the Gulf of Suez at the oil canal. This information is depicted on map 12. This coral archipelago marks the northern entrance of the Gobaal straits, which serve as the route for all shipping lines heading towards the Gulf of Suez and the Suez Canal (Figure 1).

The three islands are oriented in a northwest to southeast direction, with lengths varying between 2.5 and 3 kilometers. All of them are coral reefs, consisting of a ten-meter-thick covering of coral interspersed with sandy deposits. These three islands correspond to the areas of the sea that were enclosed by the Al-Ashrafi reef, a coral reef. The geographical features of the region where the three islands are situated consist of intricate coral reefs that are submerged below. These reefs are interspersed with tiny waterways that are well-suited for navigation by fishing boats and tourist vessels.

Tawila, Hamra, and Umm Al-Basyan are renowned tourist and diving destinations. Coral reefs, fish, and other marine life inhabit the islands. Because of their proximity to the Gobaal Strait shipping waterway, the islands are critical for navigation. Hamra Island is situated west of Tawila. The island measures approximately 3 kilometers in length and 1 km in width. The island is low, reaching 20 meters. Mangrove woods characterize the island.

Magawish Islands are two small islands less than 5 meters above sea level. The northern island is larger and higher than the southern. Shallow waters, no deeper than 50 meters, surround the islands. Rocks cover the east of the islands, while a lengthy coral reef connects the west with a shal-

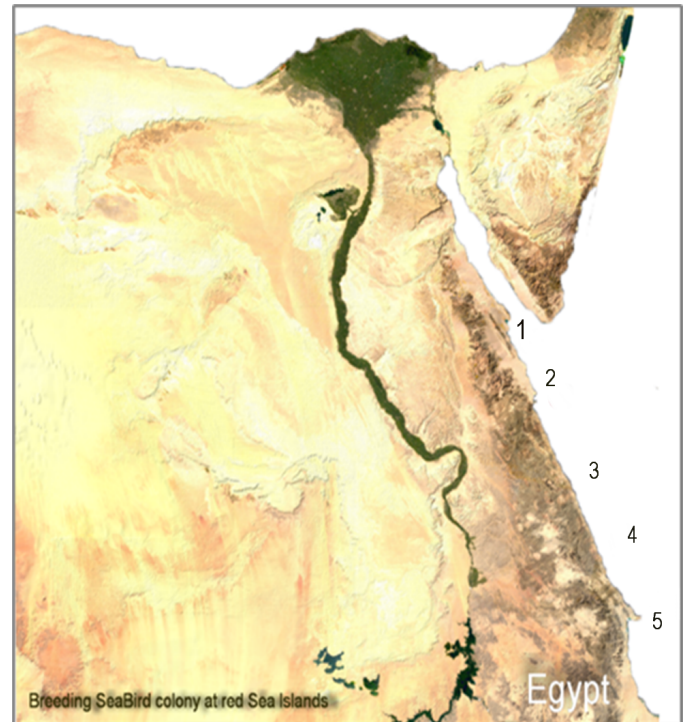


Figure 1: Study area map during seabird surveys in 2023, The visited islands in the Red Sea were as follows: 1) Ashrafi islands, 2) Hurghada islands, 3) Wadi El Gemal Islands, 4) Sayal Islands, and 5) Zabargad islands. Geographical coordinates: Latitude The GPS coordinates provided are 57 degrees, 45 minutes, and 27 seconds for latitude, and 3 degrees, 49 minutes, and 42.33 seconds for longitude.

low rocky tongue. Hotels and tourist settlements in Hurghada actively utilize the islands' snorkeling and diving sites. The bigger northern island, "Mugawish al-Kubra," has a denser and more diverse coral reef than Mugawish al-Sughra. The coral reef around the islands covers an estimated 7.5 km². Seabirds, notably gulls like the white-eyed gull, are abundant on Mugawish al-Kubra. Mugawish al-Sughra matters less.

Mahabis Island is a tiny waterway that divides this small island. It is located on a coastal coral reef 7 kilometers southwest of Mahabis Island, near Ras Qulaan. Trees and bushes cover the sandy island. The island attracts tourists with its beaches, water activities, diving, and snorkeling. Coral reefs, fish, and seagulls inhabit the island.

Wadi El Gemal is a low-lying Quaternary rock island. Shallow waters no deeper than 35 meters border the island. Coral reefs and submerged rocks line the island's western and eastern coasts. The

island sits north of a lengthy coral reef known as "Shub Gedra". Tourists visit the island for its beaches, water sports, diving, and snorkeling. Coral reefs, fish, and seagulls inhabit the island. Wadi El Gemal Island is an Egyptian nature reserve. The island is off Hurghada, Egypt. The island has resorts, hotels, restaurants, bars, and stores. Diving and snorkeling are common on the island.

The only visible Red Sea-island from Egypt and Saudi Arabia is Peridot (El Zabargad). Each side of the equilateral triangle is 3 km. The island is composed of basalt and dolerite dykes, as well as basement and metamorphic rocks. Coral reefs, evaporites, and sedimentary rocks cover these rocks. The island's peak is 265 meters high, 60 meters above sea level. An ancient rocky jetty implies mariners have known the island for generations. The island is situated near the primary shipping route of the Red Sea. Fishermen used to visit the island to catch plentiful sea turtles. Coral reefs reach 1000–500 meters around the island. Rock Island is south of Peridot. The island's beaches, water sports, diving, and snorkeling attract tourists. Coral reefs, fish, and seagulls populate the island. El Zabargad, also known as Peridot Island, is a nature reserve in Egypt. This island is off Hurghada, Egypt. Islands have resorts, hotels, restaurants, bars, and shops. The island has several divers and snorkelers.

2.3. Statistics

The statistical analysis was conducted to compare the researched sites (islands) throughout the archipelago area. Outlier detection and normality statistical tests were performed on the data to determine if it was parametric or nonparametric using Shapiro-Wilk at the 0.05 level. Chi-square test statistics at 0.05 were used to evaluate and compare non-parametric data, specifically the number of species, occupied nests, nests with two eggs, nests with one egg, inactive nests, adults, first summers, fledglings, and chick. Data analysis was conducted using the Statistical Package for Social Science (SPSS) computer software. (IBM-SPSS ver. 26.0 for Mac OS) [16].

3. Results

The survey identified a total of 9 seabird species that were discovered to be breeding at the Red Sea Islands. Brown Sula leucogaster, commonly known as the Booby, the species is known as the Sooty Gull, scientifically named *Ichthyiaetus hemprichii*. The species is known as the White-Eyed Gull, scientifically named *Ichthyiaetus leucophthalmus*. The species mentioned include the Caspian Tern (*Hydroprogne caspia*), White-cheeked Tern (*Sterna repressa*), Lesser Crested Tern (*Thalasseus bengalensis*), Greater Crested Tern (*Thalasseus bergii*), Bridled Tern (*Onychoprion anaethetus*), and Saunders's Tern (*Sternula saundersi*). Figure 1 illustrates the study areas located at the Red Sea Islands that were visited during surveys in 2023. The locations are presented as follows: The islands are numbered as follows: 1) Ashrafi Islands, 2) Hurghada Islands, 3) Wadi El Gemal Islands, 4) Sayal Islands, and 5) Zabargad Islands.

3.1. Seabird Species accounts:

3.1.1. Brown Booby *Sula leucogaster*

As a result of disturbances caused by visitors and kite-surfing safari boats on other islands, the species currently reproduces exclusively on the Zabargad and Ashrafi Islands. Ashrafi and Zabargad islands are situated at a considerable distance from popular tourist destinations. Table 1 and Figure 2 provide a concise overview of the number of nests and photographs of the Brown Booby species (*Sula leucogaster*).

3.1.2. Sooty Gull *Ichthyiaetus hemprichii*

We observed sooty gulls nesting at El Hamra, Mahabis, Shawreet, and Ashrafi South islands in 2023; 82 birds were counted during that survey. They exclusively drink fresh water sourced directly from the swimming pools at Lahmi Azure Resorts. Refer to Table 1 for the count of Sooty Gull (*Ichthyiaetus hemprichii*) individuals on Red Sea islands, Egypt, as recorded during the 2023 surveys.

Table 1: Number of nests and individuals of seabirds on Red Sea islands of Egypt, during surveys in 2023.

Name of Island	Coordinates	Date	Brown Booby (Sula leucogaster)	Sooty Gull (Ichthy aetus henniprichii)	White-eyed Gull (Larus leucophthalmus)	Caspian Tern (Hydroprogne caspia)	White-cheeked Tern (Sterna repressa)	Lesser Crested Tern (Thalasseus bengalensis)	Greater Crested Tern (Thalasseus bergii)	Bridled Tern (Onychoprion anaethetus)	Saunders's Tern (Stercorarius saundersi)
Ashrafi Islands	04612746N25353341E	January	-	-	-	30	-	-	-	-	-
		June	3	2	-	-	-	-	-	-	-
		July	-	-	-	-	250	1850	80	80	-
		June	-	1	20	-	-	1650	-	-	-
Al Hamra Islands	57452741N01623341E										
Big Gifton islands	01452711N18073357E	March	-	-	-	20	-	-	-	-	-
		July	-	-	-	-	120	-	-	-	-
		July	-	-	-	-	-	350	8	8	-
Big Magawish islands	49212709N13273352E										
Gysom Island	52872733N10003347E	July	-	-	120	-	-	-	-	-	-
Gubal Island	33922738N03953348E	July	-	-	-	5	40	-	-	-	-
Mahabis Island	04132419N05523523E	July	-	10	-	15	-	-	-	-	-
Ras Matarma Island	52032926N48533243E	July	-	-	-	-	-	-	-	-	45
Rocky Island	47752333N42653614E	July	-	-	-	-	-	350	-	-	-
Sayal Island	21812423N56023522E	July	-	-	-	-	-	-	-	450	-
Shawaeet Island	08652421N48843523E	July	-	5	-	-	-	-	-	-	-
Tawela Island	55582739N00713338E	June	-	-	200	-	-	-	-	-	-
Um El Humate Island	22662737N11903347E	June	-	-	10	-	-	-	-	-	-
Um Gawish Island	49212709N13273352E	July	-	-	1850	-	-	-	-	-	-
Wadi El Gemal island	48912439N50133509E	February	-	-	-	10	-	-	-	-	-
Zabargad Island	33.442336N45933611E	July	-	-	50	-	80	250	-	-	-
		April	18	-	-	-	-	-	-	-	-
		July	-	-	35	-	-	-	-	-	-



Brown Booby
(*Sula leucogaster*)



Sooty Gull
(*Ichthyiaetus hemprichii*)



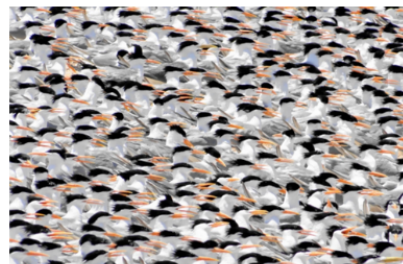
White-Eyed Gull
(*Ichthyiaetus leucophthalmus*)



Caspian Tern
(*Hydroprogne caspia*)



White-cheeked Tern
(*Sterna repressa*)



Lesser Crested Tern
(*Thalasseus bengalensis*)



Greater Crested Tern
(*Thalasseus bergii*)



Bridled Tern
(*Onychoprion anaethetus*)



Saunders's Tern
(*Sternula saundersi*)

Figure 2: Photographs taken by Habib in 2023 during surveys of seabirdson Egypt's Red Sea islands.

3.1.3. White-Eyed Gull *Ichthyaelus leucophthalmus*

The White-eyed Gull (*Larus leucophthalmus*) had the largest breeding number of 1850 pairs on Um Gawish Island, followed by 200 pairs on Tawela Island. The smallest breeding number of only 10 pairs was seen on Um El Humate Island. For further information, please refer to Table 1.

3.1.4. Caspian Tern *Hydroprogne caspia*

The breeding season of Caspian Terns (*Hydroprogne caspia*) commences in December. In July 2023, this study identified a total of 60 breeding pairs of birds on Ashrafi Island (consisting of 30 nests), Big Gifton Islands (consisting of 20 nests), Wadi El Gemal Islands (consisting of 10 nests), and the Hamata archipelago (consisting of 15 nests). On January 15, 2023, recently hatched chicks and nests with eggs were found on Gubal Island. In the third week of February, adult birds fed the fledged chicks. Young birds were also observed feeding in mid-July 2023. Refer to Table 1 for additional information regarding the breeding of Caspian Tern nests.

3.1.5. White-cheeked Tern *Sterna repressa*

In July 2023, we observed the species breeding of *Sterna repressa* on four sandy islands that we surveyed: Ashrafi (with 250 nests), Gubal (with 40 nests), Big Magawish (with 120 nests), and Wadi El Gemal (with 80 nests). Refer to Table 1 for additional information regarding the breeding habits of the White-cheeked Tern.

3.1.6. Lesser Crested Tern *Thalasseus bengalensis*

Observations were made of Lesser Crested Terns (*Thalasseus bengalensis*) breeding in heavily settled colonies on uninhabited sandy islands. The discovery of this species took place in July 2023, on four different islands. The highest numbers of nests were found on Ashrafi (1850 nests), El Hamara in two colonies (1650 nests), Big Magawish (350 nests), Wadi El Gemal (250 nests), and Rocky Island (350 nests). Refer to Table 1 for additional information regarding the breeding of Lesser Crested Tern.

3.1.7. Greater Crested Tern *Thalasseus bergii*

In July 2023, observations were made of courtship behavior, breeding, and food delivery by birds of *Onychoprion anaethetus* on two islands: El Hamra (with 50 nests) and Big Magawish (with 8 nests). The birds settled in the southern colony of Lesser Crested Terns on El Hamra Islands. Refer to Table 1 for additional information regarding the breeding of Bridled Terns.

3.1.8. Bridled Tern *Onychoprion anaethetus*

Mating behavior of Bridled Terns was found on sandy islands that included flora and fossilized corals. The nests, which contained either one or two eggs, were discovered beneath small plants and coral ledges. These nests were always shielded from direct sunlight, unlike in other species of terns. Nesting colonies of Bridled Terns were found in July 2023 on Ashrafi (with 80 nests), Big Magawish (with 8 nests), and Siyal (with 450 nests). Refer to Table 1 for additional information regarding the breeding of Bridled Terns (*Onychoprion anaethetus*).

3.1.9. Saunders's Tern *Sternula saunders*

The sandbar spans about 5 kilometers in length and has a width of 150 meters, forming two vast lagoons within its boundaries. The original settlement was situated in the western portion of the southern lagoon, characterized by salt-tolerant plant life. The majority of the sandy beach is now filled with small stones resulting from the development of the resort. The second colony was situated in the western portion of the northern lagoon, characterized by its immaculate sand and abundance of small shells. By the conclusion of the breeding season, the whole number of Saunders' Terns gathered on the largest lagoon of the northern sandbar. The total count of birds was 130, consisting of 80 adult birds and 50 fledglings. Refer to Table 1 for additional information regarding the breeding of Saunders's Tern (*Sternula saunders*).

3.2. Statistics

displays the total number of species documented/ observed on several islands. The White-eyed gull has the highest occurrence rate at 43.75%,

followed by the Sooty gull at 31.25%. The disparity in species occurrence across several islands was found to be extremely significant, as indicated by the Chi-square test ($p < 0.001^{***}$), as seen in Table 2 and Figures 3 and 4.

3.3. Changes in breeding pairs for seabird species

3.3.1. Stable species

There were seabirds and non-seabirds that consistently exist and not susceptible to significant changes in population or behavior. For instance, the total number of instances of the White-Eyed Gull (*Ichthyaelus leucophthalmus*) had a decrease from 2217 individuals in 1998 to 2200 individuals in 2023. The numbers of the Western Reef Heron (*Egretta gularis*) experienced a growth from 27 individuals in 1998 to 30 individuals in 2023. In 2012, a newly discovered species of tern called Saunders's Tern (*Sternula saunders*) was identified (Table 3 and Figure 3-5).

3.3.2. Severe decline in numbers of seabird species

nd Figures 3 and 5 depict the variations in the reproductive count of seabirds observed in 2023, as compared to the reported counts of individuals in 1993 and 1998 in the preceding period. Literature The population of White-cheeked Terns (*Sternarepressa*) has experienced a decline from 2500 pairs in 1983/84 to 490 pairs in 2023. The total number of Sooty Gulls (*Ichthyaelus hemprichii*) has declined from 110 individuals in 1998 to 31 individuals in 2023. The total number of White-cheeked Tern *Sterna repressa* pairs has declined from 2500 in 1983/84 to 490 by 2023. The overall number of Sooty Gulls (*Ichthyaelus hemprichii*) declined from 110 individuals in 1998 to 31 individuals in 2023. The overall count of Greater Crested Terns (*Thalasseus bergii*) declined from 152 individuals to 58 individuals in the year 2023. The total number of Ospreys (*Pandion haliaetus*) declined from 66 individuals to 31 individuals in the year 2023.

3.3.3. Increase in numbers of seabird species

Seabird species are experiencing an increase in numbers. Particularly, Table 3 and Figure 5 clearly demonstrated that the number of Lesser Crested Terns (*Thalasseus bengalensis*) has experienced

a significant rise, rising from 1317 individuals in 1998 to 4450 individuals in 2023. The number of Sooty Falcons (*Falco concolor*) has had a significant growth, rising from 22 individuals in 1998 to 135 individuals in 2023. The bird census conducted to determine the number of Sooty Falcons on the Egyptian Red Sea islands recorded a total of 170 pairs. In this survey of 2023 at Wadi el Gemal, specifically a total of 135 pairs were observed, which signifies a decrease of 27% over a span of around 15-20 years. Explaining the fall of the Sooty Falcon in Egypt and other locations is a challenging task. For instance, nearly all islands in the Red Sea of Egypt have been officially declared as nature reserves, guaranteeing their protection from any form of development, including tourism. Sooty terns depend on Red Sea islands for sustenance and shelter from predators, including colonial waterbirds and migrant passerines. Avoiding any disruption to the falcons and their prey, especially in Wadi Al Gemal, is of utmost importance. During the 2023 study, I found that it is important to eliminate minor threats such as the entanglement of young birds in fishing nets and the use of juvenile Sooty as decoys by falconers to hunt Peregrine Falcons (*F. peregrinus*) and Saker Falcons (*F. cherrug*). The total number of instances of the White-Eyed Gull (*Ichthyaelus leucophthalmus*) had a decrease from 2217 individuals in 1998 to 2200 individuals in 2023.

3.4. Change in breeding time for white-eyed gull

Surveys conducted in 2023 along Egypt's Red Sea coast and islands revealed a substantial number of many seabird species, with notable breeding activity observed for the White-eyed Gull, indicating significant numbers for the area. With a total of 2672 nests observed throughout the surveys, which corresponds to around 8000 individuals, it can be concluded that Egypt harbors nearly 30% of the worldwide population during the breeding season. During the mating season, Egypt serves as a habitat for more than 30% of the worldwide population of White-eyed Gulls, owing to their large population size (Table 4).

Table 2: The total number of seabird species documented on the various islands of Egypt's Red Sea.

Island		Species								Total no. of species recorded
		Sooty Gull	Caspian Tern	White- Eyed Gull	White- Cheeked Tern	Lesser Crested Tern	Swift Tern	Bridled Tern	Saunders Tern	
1	Asharafi Island	1	1	-	1	-	-	1	-	5
2	El Hamra Island	1	-	1	-	1	1	-	-	4
3	Lahmi Azure resort	1	-	-	-	-	-	-	-	1
4	Mahabis island	1	-	-	-	-	-	-	-	1
5	Shawareet island	1	-	-	-	-	-	-	-	1
6	Big Gifton island	-	1	-	-	-	-	-	-	1
7	Wadi El gemal is- land	-	1	1	1	1	-	-	-	4
8	Hamata islands	-	1	-	-	-	-	-	-	1
9	Tawila island	-	-	1	-	-	-	-	-	1
10	Umm El Humate is- land	-	-	1	-	-	-	-	-	1
11	Gysom Island	-	-	1	-	-	-	-	-	1
12	Big Magawish Island	-	-	1	1	1	1	1	1	6
13	Zabargad Island	-	-	1	-	1	-	-	-	2
14	Gubal islands	-	-	-	1	-	-	-	-	1
15	Siyal island	-	-	-	-	-	-	1	-	1
16	Ras Matarma	-	-	-	-	-	-	-	1	1
17	Rocky island	-	-	-	-	1	-	-	-	1
Total no. of islands recorded		5	4	7	4	6	2	3	2	
% occurrence/ observed is- lands		31.25	25	43.75	25	37.5	12.5	18.75	12.5	

*, **, ***, significant at $p < 0.05$, 0.01 , 0.001 ; NS, non-significant at $p > 0.05$

4. Discussion

4.1. Challenges faced by the breeding pairs of seabird species

The following are the general threats to breeding seabirds at Red Sea Islands discovered breeding during the survey of the island, which could be the reasons for declining of the assessed species.

The surveyed locations are exposed to pollution risks from oil rigs and bilge water discharged by tourist vessels. Oil pollution can have catastrophic consequences for birds that breed on islands, as they rely on plunge diving to hunt along the reef edge, which makes them susceptible to

the harmful effects of oil. Seabirds face a significant risk from oil spills originating from offshore drilling platforms and contaminated bilge water discharged by ships [14]. The survey also revealed a significant presence of oil pollution from different sources, including bilge water from tourism boats, which is the primary contributor of oil pollution in the surveyed area. The presence of oil pollution can have catastrophic consequences for the breeding seabirds on these islands, as they prefer to forage in shallow water regions of the Red Sea. Seabirds are vulnerable to oil contamination due to their feeding behavior, but this problem can be eliminated. From a practical viewpoint, oil pollu-

Table 3: Presents a comparison of breeding numbers (pairs) of breeding numbers of seabird species surveyed on the various islands of Egypt's Red Sea between the years 1983/1984, and 1998 with the values being recorded in 2023 [3, 7, 17, 18].

Seabird species	1983/1984 counted	1998 counted	This survey in 2023
Brown Booby <i>Sula leucogaster</i>	56	78	47
Sooty Gull <i>Ichthyaetus hemprichii</i>	60	110	31
White-Eyed Gull <i>Ichthyaetus leucophthalmus</i>	974	2217	2200
Caspian Tern <i>Hydroprogne caspia</i>	165	178	135
White-cheeked Tern <i>Sterna repressa</i>	2500	660	490
Lesser Crested Tern <i>Thalasseus bengalensis</i>	1700	1317	4450
Greater Crested Tern <i>Thalasseus bergii</i>	1	152	58
Bridled Tern <i>Onychoprion anaethetus</i>	1096	368	538
Saunders's Tern <i>Sternula saunders</i>	0	0	45
Non-Seabird species			
Spoonbill <i>Platalea leucorodia archeri</i>	11	9	12
Western Reef Heron <i>Egretta gularis</i>	21	27	30
Sooty Falcon <i>Falco concolor</i>	114	22	135
Ospreys <i>Pandion haliaetus</i>	38	66	31

Table 4: Thecurrent status of breeding birds in the Red Sea region, as assessed by Birdlife International and IUCN in 2023, is reported here [18].

Species	Status
Brown Booby <i>Sula leucogaster</i>	Least Concern
Sooty Gull <i>Larus hemprichii</i>	Least Concern
White-Eyed Gull <i>Larus leucophthalmus</i>	Near-Threatened (2016)
Caspian Tern <i>Sterna caspia</i>	Least Concern
White-Cheeked Tern <i>Sterna repressa</i>	Least Concern
Lesser Crested Tern <i>Sterna bengalensis</i>	Least Concern
Swift Tern <i>Sterna bergii</i>	Least Concern
Bridled Tern <i>Sterna anaethetus</i>	Least Concern
Saunders's Tern <i>Sternula saundersi</i>	Least Concern

tion is a threat to seabirds who breed on these islands, as Red Sea seabirds have a preference for shallow water for feeding. This leaves them vulnerable to oil pollution, which can harm their feather

insulation and result in the death of chicks or adult birds that ingest oil when preening. The investigated area exhibited a diverse array of oil pollution stemming from many sources, with the primary contributor being bilge water from tourism boats. The presence of oil pollution can cause severe harm to spoonbills and sea birds that breed on such islands, as spoonbills in the Red Sea like to feed in shallow water regions. The feeding behavior of spoonbills makes them vulnerable to oil pollution, as it can strip the protective layer of their feathers and could lead to the death of their offspring or the adult birds themselves if they ingest the oil while attempting to clean their feathers [10, 13, 14]. Finally,

Also, Western Ospreys in Egypt face threats mostly from predation by Red Foxes (*Vulpes vulpes*) and choose to breed on remote offshore islands as a strategy to avoid this danger, particularly during evenings. Besides, seabirds are preyed upon by House rate *Rattus rattus* on far-off offshore islands when they mate and roost [14].

Furthermore, seabird breeding was found to be reduced as a result of human disturbance caused by the arrival of fishermen during mating seasons.

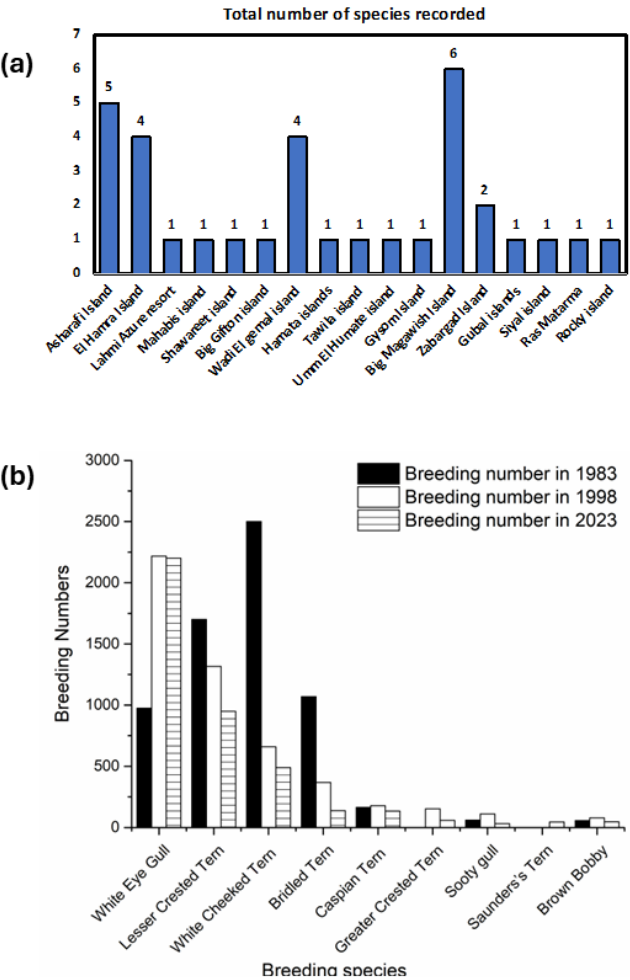


Figure 3: a) The total number of species richness recorded on the various islands of Egypt's Red Sea. b) A comparison was made between the total surveyed populations of seabird species in 2023 and those documented in 1983 and 1998.

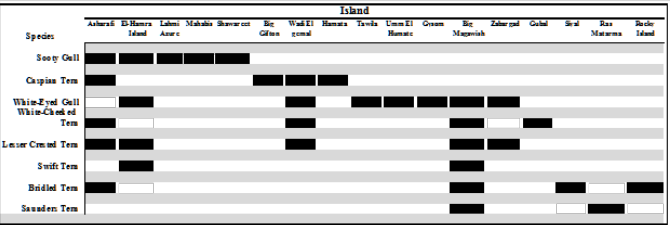


Figure 4: Occurrence of seabird species surveyed on the various islands of Egypt's Red Sea.

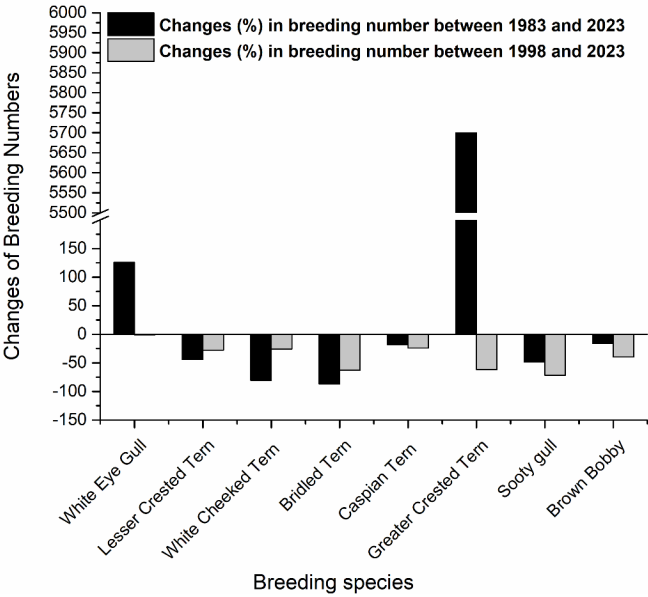


Figure 5: Changes (%) of the breeding number of seabird individuals recorded in 1983 and 1998) in breeding numbers of seabird species surveyed on the various islands of Egypt's Red Sea in 2023.

In addition, the arrival of visitors and fisherman on islands can result in birds abandoning their nests. Specifically, kite surfers arrived on safari boats and spent four nights surfing at Ashrafi Island. The presence of feathers as insulation can lead to the death of chicks or parents when they accidentally ingest oil while trying to remove it during preening. Furthermore, on offshore islands, the house rat *Rattus rattus* preys on seabirds during nesting and roosting periods in the evenings [14]. For instance, the construction of a tourist café on the southern part of Big Gifto has caused birds to build new nests on the northern side of the island. Additional disruption arises when fisherman visit during the breeding season to collect eggs, while kite surfers often arrive on the islands via safari boat and may even stay overnight on Ashrafi.

Further investigation is necessary to determine the reasons behind the recent decline in the population of Egyptian Red Sea Seabirds. This research should involve the use of color rings to individually monitor birds. One simple method to minimize disturbance on breeding islands is to display signs that prohibit humans and fishermen from accessing breeding areas during the breeding season. Finally, an effective method to minimize disruption

tion at breeding islands is to erect signs during the breeding season that explicitly forbid human and fishing activities in the breeding areas.

4.2. *Impact of Climate Change on White-Eyed Gull Breeding Phenology*

Mainly species breed throughout the spring or summer, except for two species that reproduce during the winter. Nesting birds encounter more stress due to the extreme temperatures that occur during the summer due to climate change. There is compelling evidence that birds are producing eggs earlier in response to climate change [19]. Approximately 60% of research on egg-laying indicates long-term increases in laying dates that align with patterns of global warming [19]. A 25-year study conducted in Europe on UK birds revealed that, out of the 65 species evaluated, 20 of them deposited eggs around 8.8 days earlier on average [20, 21]. A separate study revealed a substantial (statistically significant) correlation between the timing of egg-laying and climate change [21]. A study conducted in 2023 on the Red Sea coast and islands of Egypt revealed that White-eyed Gulls (*Larus leucophthalmus*) have been modifying their mating schedules during the past twenty years. The mating season of *Larus leucophthalmus* has shifted from July to late April since 1985 [3]. Previously, the primary breeding period occurred in July and August. This study suggests that global warming may have contributed to the emergence of several bird species that are new to Egypt, as well as the expansion of their breeding habitats. Additionally, it may have caused the White-Eyed Gull to start breeding earlier than usual. With a total of 2672 nests observed throughout the surveys, which corresponds to around 8000 individuals, it can be concluded that Egypt harbors nearly 30% of the worldwide population during the breeding season. Consequently, it is imperative to safeguard these avian species from potential risks, such as disruptions caused by tourists. Fishermen gathered eggs on the belief that it would enhance their sexual desire. Environmental pollution poses a severe threat to the species due to its year-round surface feeding behavior, making it vulnerable to oil pollution and entrapment in fishing lines or ropes. In order to

safeguard these crucial colonies, it is imperative to install signage that prohibits human access to the area during the breeding season.

5. Conclusions

Human disturbance is caused by the arrival of fishermen during breeding seasons, kite surfers travel to Ashrafi Island by safari boat and stay for four nights to engage in their sport, the primary causes of oil pollution in this area are the oil rigs and the bilge water from tourism boats. These islands are susceptible to human interference. Besides, *Rattus rattus*, a species of House rat, feeds on seabirds while they are mating and roosting on remote offshore islands. When a tourist café was constructed on the southern side of Big Giftun, birds were compelled to choose new nesting sites on the northern side. Further investigation is required to ascertain the reasons behind the potential decrease in the numbers of Egyptian Red Sea Seabirds, which may involve the use of color ring monitoring. Installing signs that discourage humans and fishermen from accessing breeding islands during the breeding season can effectively minimize disturbance. Finally, this study revealed the lack of Red Sea island seabird data and research. We advocate completing this study and building a database of seabird counts, migration dates, breeding dates, and egg laying, with periodic climate change monitoring. Developing regulations to protect Red Sea seabirds, especially endangered species like White-eyed seagull. Additionally, Red Sea islands must be protected from pollution, notably oil.

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