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Avian Conservation and Management

Census of breeding avifauna and the status of Audouin's Gull (*Ichthyaetus audouinii*) along the eastern Mediterranean coast of Turkey

Censo de avifauna reproductora y el estado de la Gaviota de Audouin (*Ichthyaetus audouinii*) a lo largo de la costa Mediterránea oriental de Turquía

Korhan Özkan [1] and Batuhan Ç. Yapan [1]

ABSTRACT. We conducted the first extensive breeding bird and habitat survey across 21 islands and islets spanning 600 km of the eastern Mediterranean coastline of Turkey in 2016. Eight of the 21 islands hosted breeding colonies of at least one of three seabird species: European Shag (*Gulosus aristotelis*) on four islands and two coastal cliffs with 9–29 breeding pairs, Yellow-legged Gull (*Larus michahellis*) on eight islands with 145–175 breeding pairs, and Audouin's Gull (*Ichthyaetus audouinii*) on one island with 6–7 breeding pairs. Two Scopoli's Shearwaters (*Calonectris diomedea*) were also observed during the coastal cruise, but no conclusive breeding evidence was collected. The single Audouin's Gull breeding colony alternated between two nearby islands, and the breeding population fluctuated between 6–10 pairs between 2016 and 2023. Comparisons between previous population estimates and the present survey indicated that the Audouin's Gull breeding colony has suffered a ~65–80% population loss in the last five decades. Habitat surveys revealed that 13 islands had some vegetation cover. Bushes were the dominant vegetation and hosted the highest seabird nest abundance. However, the highest seabird nest density was observed in herbaceous vegetation, which had only marginal coverage on the islands, potentially due to overgrazing by introduced rabbits and goats. Furthermore, surveys revealed occasional mortality of gull eggs, chicks, and adults as well as anthropogenic pressures on seabird breeding habitats such as uncontrolled recreational use and introduced mammals. The islands also hosted 15 other breeding bird species, including large populations of Alpine Swift (*Tachymarptis melba*, ~270 pairs) as well as several raptor species. Overall, our results indicated that there is significant seabird breeding activity in the eastern Mediterranean coastline of Turkey and an urgent need for ecosystem management to protect the habitat quality of these islands for seabird breeding populations.

RESUMEN. En 2016, hemos realizado el primer censo extensivo de aves reproductoras y hábitat a lo largo de 21 islas e islotes que abarcan 600 km de la costa Mediterránea oriental de Turquía. Ocho de estas 21 islas albergaron colonias reproductoras de por lo menos una de tres especies de aves marinas: Pelusa Europea (*Gulosus aristotelis*) en cuatro islas y dos riscos costeros con 9-29 parejas reproductoras, Gaviota de patas amarillas (*Larus michahellis*) en ocho islas con 145-175 parejas reproductoras, y Gaviota de Audouin (*Ichthyaetus audouinii*) en una isla con 6-7 parejas reproductoras. Dos Pardelas de Scopoli (*Calonectris diomedea*) también fueron observadas durante el crucero costero, pero no se colectó ninguna evidencia concluyente de reproducción. La única colonia reproductora de Gaviota de Audouin se alternaron entre dos islas cercanas, y la población reproductora fluctuó entre 6-10 parejas entre 2016 y 2023. Comparaciones entre estimaciones de población previas y el presente estudio indicaron que la colonia reproductora de Gaviota de Audouin ha sufrido una pérdida poblacional de ~65–80% en las últimas cinco décadas. Estudios de hábitat revelaron que 13 islas tuvieron algo de cobertura vegetal. Los arbustos fueron la vegetación dominante y albergaron la mayor abundancia de nidos de aves marinas. Sin embargo, la mayor densidad de nidos de aves marinas fue observada en vegetación herbácea, que solamente tuvo cobertura marginal en las islas, potencialmente debido al pastoreo excesivo por conejos y cabras introducidas. Además, los censos revelaron mortalidad ocasional de huevos de gaviotas, pichones y adultos, como también presiones antropogénicas sobre los hábitats de aves marinas reproductoras, como por ejemplo uso recreacional no controlado y mamíferos introducidos. Las islas también albergaron otras 15 especies de aves reproductoras, incluyendo poblaciones grandes de Golondrina Alpina (*Tachymarptis melba*, ~270 parejas), como también varias especies de rapaces. En general, nuestros resultados indicaron que existe una actividad reproductora de aves marinas significativa en la costa Mediterránea oriental de Turquía y existe una necesidad urgente de manejo del ecosistema para proteger la calidad del hábitat de estas islas para las poblaciones reproductoras de aves marinas.

Key Words: *anthropogenic pressures; breeding bird survey; Ichthyaetus audouinii; Larus michahellis; Mediterranean island avifauna; seabirds*

INTRODUCTION

Seabirds are at the top of marine food webs and are important indicators of ecosystem health (Danckwerts et al. 2014). There are approximately 346 species of seabirds, and nearly one-third of them are threatened globally (Croxall et al. 2012). A steep declining trend has been observed in many seabird populations (Dias et al. 2019). An analysis of long-term monitoring datasets revealed that ~70% of all monitored seabird populations have declined dramatically between 1950 and 2010 (Paleczny et al. 2015). Habitat loss and degradation (Kavelaars et al. 2020), fishing bycatch, plastic pollution (Anderson et al. 2011), climate change (Grémillet and Boulinier 2009), and invasive mammals are among the many drivers of these population declines (Croxall et al. 2012).

[1]Institute of Marine Sciences, Middle East Technical University, Mersin, Türkiye

Islands located near pelagic feeding areas and without terrestrial predators provide suitable breeding grounds for seabirds (Buxton et al. 2016). Most of the 346 seabird species breed in colonies on islands (Mulder et al. 2011). Habitat degradation and loss on islands, recreational human use, climate change, and introduced species may negatively affect seabird breeding success (Platenberg 2007, Croxall et al. 2012). Negative effects of invasive predator introductions, such as rodents, on seabird populations have been widely documented (Reaser et al. 2007). Furthermore, excessive levels of grazing by invasive mammals may cause habitat loss and erosion on islands (Reaser et al. 2007). An analysis of 968 islands around the world, hosting 1362 populations of 98 threatened seabird species, revealed that invasive species were present on at least 60% of these islands, which hosted the entire populations of 29 seabird species (Spatz et al. 2014).

The Mediterranean Sea has 15 seabird species, four of which are endemic (Coll et al. 2010), and more than 5000 islands and islets providing breeding grounds for seabirds. The Mediterranean island ecosystems also suffer from significant anthropogenic pressures (Coll et al. 2010). For example, 68% of the western Mediterranean islands host invasive rats (*Rattus* spp.; Ruffino et al. 2009), and significant negative effects of invasive species on seabird breeding success were documented on the Balearic Islands (Traveset et al. 2009). A total of 28 seabird species has been observed on eastern Mediterranean coasts of Turkey according to bird watcher records from the last 60 years (Güçlüsoy et al. 2014, eBird 2017). Although there is a relatively high diversity of seabird species for such an oligotrophic ecosystem, information on breeding seabird populations in the region is limited to citizen science records and a few studies with limited spatial coverage (Çağlayan 2003, Ayaş et al. 2008, eBird 2017).

Audouin's Gull (*Ichthyaetus audouinii*) is a seabird species with a breeding distribution mostly confined to the Mediterranean Sea. It experienced a dramatic population decline in the 20th century, when its global population declined to ~1000 pairs in 1975 (Birdlife International 2020). Coastal development, anthropogenic disturbance, fishing by-catch, predation, and competition with the more abundant Yellow-legged Gull (*Larus michahellis*) for nesting sites were suggested as the potential pressures resulting in this population crash (Tavecchia et al. 2007). The global Audouin's Gull population recovered to ~22,000 pairs by 2007 as a result of the sudden recovery of the breeding population in Ebro Delta, Spain (Oro and Pradel 2000). Since 2007, the global Audouin's Gull population has exhibited a decreasing trend driven mostly by changes in the breeding colony in Ebro Delta, potentially due to the decrease in fishery discards (García-Tarrasón et al. 2015, Calado et al. 2021), and increased predation after fox (*Vulpes vulpes*) was introduced to the Ebro Delta breeding colony in 1997 (Payo-Payo et al. 2018). The global population size of Audouin's Gull in 2020 was estimated to be 15% lower than the population in 1996, and it has been predicted to continue decreasing by an additional 31–40% between 2006 and 2030 (BirdLife International 2020). Accordingly, Audouin's Gull was assessed as vulnerable by the IUCN in 2020 (BirdLife International 2020).

Audouin's Gull has breeding colonies with small population sizes and scattered distribution on the Aegean Islands and eastern Mediterranean Sea (EBCC 2022). A significant decrease in Audouin's Gull population size was observed in Cyprus during the last few decades (Hellicar 2016). A total of six Audouin's Gull breeding locations have been reported in Turkey between 1989 and 2008 with an estimated total breeding population of 70–120 pairs (Ertan et al. 1989, Yarar and Magnin 1997, Çağlayan 2003, Kılıç and Eken 2004, Ayaş et al. 2008, Onmuş and Gönülal 2019). The discovery of a new breeding colony of 35 breeding pairs in 2018 on Gökçeada (Imbros) Island extended the Audouin's Gull breeding range in the Aegean Sea to 40° N (Onmuş and Gönülal 2019). This discovery increased the total breeding population estimate to 70–140 pairs on Turkish coasts (Onmuş and Gönülal, 2019). However, population trends and gene flow among breeding colonies along the Turkish coastline and wider region are unknown because of the lack of ringing and long-term monitoring studies.

In this study, we documented the abundance and distribution of seabird breeding colonies as well as breeding habitat characteristics and pressures along the eastern Mediterranean coastline of Turkey by conducting an extensive survey covering all the islands and islets east of 30.5° E for the first time. We further monitored the single breeding Audouin's Gull colony in the region between 2016 and 2020 as well as in 2023 to document the population trend of this vulnerable seabird species of conservation concern.

METHODS

Study site

All islands and islets located across the entire eastern Mediterranean coastline of Turkey between Antalya and Hatay provinces (~600 km coastline) were surveyed (Fig. 1). This survey covered most of the islands in the Cilician basin of Mediterranean sea with the exception of a few small islands of the northern coasts of Cyprus. All the islands were in the territorial waters of Turkey, without any legal restriction on access of civilians or protection status. However, seven islands were inaccessible because of steep cliffs and rocky shores. A total of 21 islands larger than 300 m² were surveyed (Table 1). The islands were generally small (5281 m² median size) and close to the mainland (234 m median

Fig. 1. Map of the survey area. The islands with a breeding seabird colony were indicated with green triangles. The inset on the lower left corner depicts the location of the entire survey area in eastern Mediterranean.

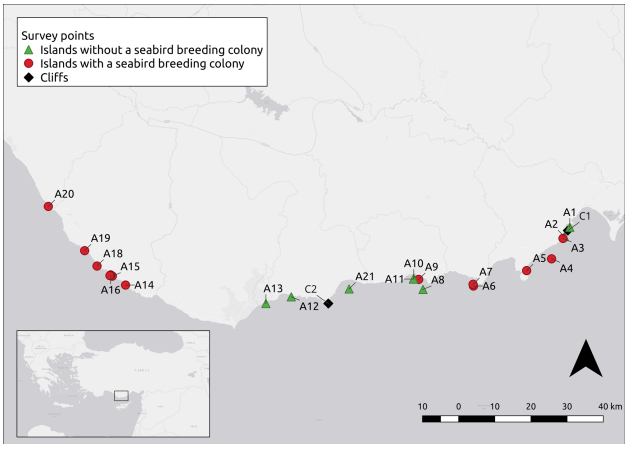


Table 1. Locations and morphological characteristics of the islands.

	Island name	Latitude	Longitude	Area (m^2)	Maximum altitude (m)	Distance to mainland (m)
A1	Boğsak Adası	36°16′01.02″ N	33°49′38.04″ E	74508	43	351
A2	Güvercin Adası	36°14′38.53″ N	33°48′38.03″ E	4421	9	234
A3	Güvercin Kayalığı	36°14′22.53″ N	33°48′22.29″ E	316	4	22
A4	Dana Adası	36°11′21.17″ N	33°46′17.13″ E	2680486	250	2262
A5	Kösrelik Adası	36°09′36.69″ N	33°41′42.46″ E	63511	45	214
A6	Beşparmak Büyük Ada	36°07′19.74″ N	33°31′57.59″ E	129837	107	540
A7	Beşparmak Küçük Ada	36°07′35.30″ N	33°31′53.14″ E	47944	50	529
A8	Yılanlı Ada	36°06′49.65″ N	33°22′42.16″ E	9285	17	1795
A9	Yelkenli Adası	36°08′18.74″ N	33°21′55.11″ E	12371	12	32
A10	Aydıncık Küçük Ada	36°08′26.98″ N	33°21′0.14″ E	11975	4	638
A11	Aydıncık Büyük Ada	36°08′21.65″ N	33°20′56.30″ E	11794	26	728
A12	Bozyazı Adası	36°05′44.04″ N	32°58′32.80″ E	10363	16	197
A13	Mamure Adası	36°04′44.17″ N	32°53′53.46″ E	2031	6	297
A14	Yalcılı Adası	36°07′28.43″ N	32°28′08.97″ E	5123	29	47
A15	Çıpçılı Kaya	36°08′47.88″ N	32°25′43.17″ E	2042	16	165
A16	Kalaytaşı Adası	36°08′58.57″ N	32°25′25.22″ E	3297	5	12
A17	Kurt Adası	36°08′51.84″ N	32°25′17.52″ E	2862	15	352
A18	Doğanlı Adası	36°10′17.36″ N	32°22′55.10″ E	731	18	16
A19	Ilısu Adası	36°12′33.79″ N	32°20′38.74″ E	864	12	219
A20	Kuzu Kayalığı	36°19′06.15″ N	32°13′59.24″ E	689	4	54
A21	Aksaz Adası	36°06′53.82″ N	33°09′08.95″ E	3268	12	2592

*Probable used nests on coastal cliffs, C1: 36°15′32.4″ N, 33°49′15.6″ E, C2: 36°4′44.4″ N, 33°5′20.4″ E.

distance), with only a single island farther than 2.5 km from the mainland. The maximum and median elevations were 250 and 16 m above sea level, respectively. The islands were mainly of karst origin and covered by rocks, and none of the islands had permanent surface water.

Breeding bird and habitat surveys

Each island was surveyed for breeding seabirds, overall avifauna, and habitat structure. The survey was conducted between 26 May and 4 June 2016 during a coastal cruise on board the RV-Lamas. First, total seabird population size on an island was estimated by counting perched and flying individuals: (i) by covering the entire circumference of the island by boat on arrival, (ii) at the beginning, and (iii) end of survey at the highest point of the island. The highest of these three counts was accepted as total population size for a seabird species on that island. The population size was converted to breeding pairs, where appropriate, by diving by two. Second, seabird nests and juvenile densities as well as other breeding avifauna were surveyed by using transect counts. Two orthogonal transects were chosen covering the longest two dimensions of an island and surveyed by walking < 3 km/h in as straight a line as possible. Any seabird nest, chick, or juvenile (chicks with fully developed flight feathers) within a 3 m distance on each side of the transect was recorded. Furthermore, any other bird seen or heard was recorded with its abundance, distance to the transect, and relevant breeding code (Bibby 2004). In addition to the standard transect surveys, any new bird species encountered outside of transect surveys (e.g., during transfer from the boat, etc.) was recorded as opportunistic counts with a breeding code. Opportunistic counts were used for compiling island species lists but not used for comparative analyses. The breeding code data were classified as confirmed, probable, and possible breeding evidence (Bibby 2004). Transects were divided into sections according to the habitat characteristics and dominant vegetation type (Table 2), and all transect counts were registered separately for each section. Start and end coordinates, altitudes, habitat type, vegetation characteristics, and dominant plant species were recorded in each section. Dominant plant species were sampled, photographed, and identified to species level, when possible. Evidence of mammal presence (feces or footprints) and anthropogenic pressures (presence of fishing gear and litter) were also recorded. The survey methods were not adequate to determine rat presence, which is a potential mammal predator in these island ecosystems. Any mortality on seabird egg and individual was also recorded; however, it was not possible to determine the causes of these mortalities. It was not possible to cover the entire dimensions of the largest island, Dana Island (A4), and thus, four transects perpendicular to the coast and up to 75 m altitude were surveyed. Furthermore, a researcher continuously surveyed the coastline and seascape during the cruise for foraging seabirds and potential breeding colonies on the mainland. Sites with potential seabird breeding colonies on the mainland were carefully examined for breeding evidence and total number of nests.

Table 2. Habitat types observed on the islands and their descriptions.

No.	Habitat type	Description
1	Beach	Shore covered by sand or pebbles with low slope
2	Bush	Area covered by perennial short plants
3	Cliff	Very steep generally rocky slope
4	Forest	Area covered by trees; mostly pine species
5	Forb	Area covered by annual, dicotyledonous plants.
6	Maquis	Area covered by typical large bushes and short trees typical for Mediterranean climate zone
7	Olive stand	Area covered by olive trees planted by humans
8	Rock	Rocky coastline with low to moderate slope
9	Grass	Area covered by monocotyledonous graminoid plants

The Aydıncık region was further visited between 2017 and 2020 as well as in 2023 to elucidate the temporal variation of the single Audouin's Gull and three Yellow-legged Gull breeding colonies. The surveys were conducted within the breeding period (between 17 May and 6 June) each year. Each year, the Audouin's Gull breeding colony was located and the same breeding seabird survey

methods were repeated. Audouin's Gull total nest counts could not be performed in 2018 and 2023, when the Audouin's Gull counts were performed, it was only from a distance.

RESULTS

Eight of 21 islands hosted seabird breeding colonies in 2016 (Table 3). Confirmed breeding evidence was collected for Yellow-legged Gull, Audouin's Gull, and European Shag (*Gulosus aristotelis*) on eight, one, and four islands with estimated populations of 145-175, 6-7, and 9-29 breeding pairs in total, respectively (Table 3). Furthermore, European Shag probably bred on two coastal cliffs on the mainland (Table 3). Yellow-legged Gull and Audouin's Gull were actively breeding during the survey period, and we collected direct breeding evidence. The majority of Yellow-legged Gull chicks were already fledged, but Audouin's Gull was still incubating eggs, and hatched chicks were not fully fledged by early June. In addition to eight islands with breeding colonies, Yellow-legged Gulls were further observed in Islands 4, 5, 6, 7, 9, and 14 during the transect surveys, however, with very low numbers (< 3) and without conclusive breeding evidence. The European Shag had already bred and their chicks fledged before the survey period, and thus we carefully examined recently used nests on islands and feces markings on cliffs. European Shag breeding population estimates based on nest abundance were consistent with the number of adult and juvenile birds (34 adults and 17 juveniles) encountered during the survey. We also observed two Scopoli's Shearwaters (*Calonectris diomedea*) west of Göksu Delta, but were unable to find any evidence of breeding.

Table 3. The islands with seabird breeding colonies and breeding populations (breeding pairs) estimated in the 2016 survey. The highest breeding evidence is given in parenthesis (C, confirmed; Pr, probable; Po, possible).

Island code	*Gulosus aristotelis*	*Ichthyaetus audouinii*	*Larus michahellis*
A1	4–6 (Po)		60–70 (C)
A2			10–15 (C)
A8	2–8 (C)	6–7 (C)	15 (C)
A10	1–2 (Po)		10–12 (C)
A11			25–30 (C)
A12			6–8 (Pr)
A13			13–15 (C)
A21	2–5 (C)		5–10 (C)
C1*	0–7 (Pr)		
C2*	0–1 (Pr)		
Total	9–29	6–7	145–175

*Probable used nests on coastal cliffs, C1: 36°15′32.4″ N, 33°49′15.6″ E, C2: 36° 04′44.4″ N, 33°05′20.4″ E.

Audouin's Gull had a stable breeding population of 6–10 pairs in the Aydıncık region between 2016 and 2023 (Table 4). The single breeding colony alternated between two islands, Yılanlı Ada (A8) and Aydıncık Küçük Ada (A10). The Audouin's Gull breeding colony was located within a larger Yellow-legged Gull breeding colony on both islands, but they used separate patches of the islands for breeding. The breeding patches of the Audouin's Gull on both islands tended to have more rock and herbaceous vegetation cover compared to those of Yellow-legged Gull, which preferred forb and bush habitats. Occasional adult, chick, and egg mortality was observed on both islands (Table 5). Yellow-legged Gulls had a stable breeding population of ~90–125 pairs on three islands (A8, A10, A11) in the Aydıncık region between 2016 and 2020 (Table 6).

Table 4. Audouin's Gull (*Ichthyaetus audouinii*) adult, nest, egg, and chick counts, and observed mortality during the surveys between 2016 and 2023. Audouins's Gull nest counts could not be replicated in 2018 and 2023. NA denotes not available.

Year	Island	Adults	Nest	Chick and eggs	Mortality
2016	A8	13	7	11 C + 5 E	6 dead chicks, 1 broken, 2 infested eggs
2017	A10	20	7	16 C + 16 E	1 dead adult
2018	A10	15	NA	NA	1 dead adult
2019	A10	13	10	26 E	No mortality observed
2020	A8	10	8	4 C + 5 E	2 dead chicks, 2 abandoned eggs
2023	A10	18	NA	NA	NA

Fifteen bird species other than seabirds were observed with breeding evidence during the entire survey, 13 of which were observed during the transect counts (Table 7). Breeding could only be confirmed for the Alpine Swift (*Tachymarptis melba*), and possible breeding evidence was obtained for the remaining species. Notably, 11 islands hosted a total of ~275 pairs of Alpine Swifts, which nest among the cracks in rocks. The breeding population estimate for Alpine Swifts should be considered with caution because our survey method was not capable of accounting for foraging individuals from the mainland. In addition to the passerine birds characteristic of coastal Mediterranean habitats, we also recorded a number of raptor species (Table 7) such as the Short-toed Eagle (*Circaetus gallicus*), Eleonora's Falcon (*Falco eleonorae*), Peregrine Falcon (*Falco peregrinus*), and Eurasian Eagle-Owl (*Bubo bubo*).

The habitat surveys revealed nine main habitat types on the islands (Table 2, Fig. 2). Rock and bush habitats had the largest total cover (Table 5). Vegetation cover was observed on 13 of 21 islands. The vegetation consisted of mostly drought tolerant Mediterranean plants, and dominant plant taxa for each habitat and island are given in Table 8. Significant tree cover was only observed on two large islands, probably historically maintained by humans: a large pine forest on the largest island, Dana Adası (A4), and an olive stand on Bozyazı Adası (A12). Grass habitat had significant cover only on Yılanlı Ada (A8).

Most of the islands were easy to reach from the mainland, and several islands were used extensively for recreational fishing evidenced by litter abundance and composition as well as communications with local fisherman. Yılanlı Ada (A8), where a large seabird breeding colony existed including the single Audouin's Gull colony, was further used for overnight stays by recreational fisherman. Occasional release of domestic livestock (goats and rabbits) was also observed on these islands. Traces of rabbits (feces, burrows of individuals) were observed on four islands, a herd of domestic goats was observed on Dana Island (A4) in 2016, and two goats were observed on Aydıncık Büyük Ada (A11) in 2023. The survey was incapable of determining the presence of predatory mammals like rats. Dead seabirds were observed on five islands in 2016; however, the causes of these mortalities could not be determined (Table 8).

The islands that hosted rodent populations tended to have more abundant bush habitat. The highest seabird nest abundance was observed in bush habitat, which was the most dominant habitat type on the islands (39 seabird nests), followed by grass (10 seabird nests), and forb (6 seabird nests) habitats. However, the highest

Table 5. Percent coverage of each habitat on the islands with observed pressures and seabird mortalities during the 2016 survey. Habitat codes are given in Table 2. P denotes the presence of a habitat type observed from a distance, when a survey was not possible because of inaccessibility of an island.

Island code	Habitat Type									Observations on pressures and bird mortality
	1	2	3	4	5	6	7	8	9	
A1		80				10		10		Five dead unidentified gull
A2		48						52		
A3								100		
A4		23		21		42		14		Abundant domestic goats
A5	1	26			16	29		27		Abundant rabbit droppings and litter
A6		42	13			32		13		Abundant rabbit droppings and a rabbit
A7		30	5			37		28		
A8			8		9			22	61	12 dead unidentified gull and an infected egg. Abundant litter and significant fishing activity with an illegal hut constructed for overnight stays
A9		62						38		
A10		55						45		Six dead unidentified gull
A11		72				13		12		Six dead unidentified gull. Abundant rabbit droppings and three rabbits. Two goats were observed in 2023 visit.
A12	2	16				12	46	24		Abundant rabbit droppings. Island is located very near to the mainland with high human recreational use.
A13					31			69		A dead Little Egret (*Egretta garzetta*) and European Shag (*Gulosus aristotelis*)
A14			32			37		31		
A15		P	P							
A16								100		
A17			P		P					
A18			P		P					
A19								100		
A20								100		
A21			7		29			64		

Table 6. Yellow-legged Gull (*Larus michahellis*) counts on Aydıncık islands in breeding season between 2016 and 2020. It was not possible to conduct counts in 2017 and 2023 because of logistical constraints.

Island	2016	2018	2019	2020
A8	50	35	50	85
A10	25	40	25	16
A11	50	30	15	19
Total	125	105	90	120

nest density (80 nests per km of transect) was observed in grass habitat, followed by forb and bush habitats. The single Audouin's Gull colony preferred grass and forb habitat, while the Yellow-legged Gull nested in maquis and rock habitats, and the European Shag nested only in rock habitat (Fig. 3). No seabird nests were observed in any of the other habitat types. Islands with rabbits and goats tended to have lower seabird nest density (Fig. 4). However, low sample size in the present study prevented us from drawing any firm conclusions.

DISCUSSION

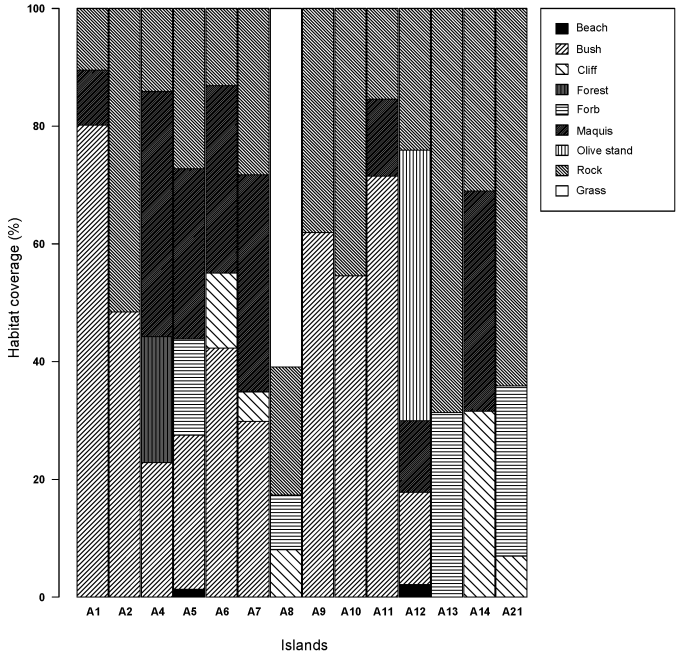
We conducted the first breeding seabird and habitat survey across all islands and islets located along the eastern Mediterranean coastline of Turkey. Because the Kleides archipelago, located in the northern tip of Cyprus (two large islands and a few small islets), constitutes the only other island habitat in the region, which host breeding colonies of Audouin's Gull, Yellow-legged Gull, and European Shag (Hellicar 2016), our results can provide insight on the status of breeding seabirds and island avifauna in the wider northeastern Mediterranean region east of 30.5° E. The survey revealed that eight of the 21 islands hosted breeding populations of at least one of the three seabird species: European Shag on four islands and two coastal cliffs with 9–29 breeding pairs, Yellow-legged Gull on eight islands with 145–175 breeding pairs, and Audouin's Gull on one island with 6–7 breeding pairs. The Yellow-legged Gull breeding population was likely an underestimate because they are well adapted to human settlements and may also breed on buildings (del Hoyo et al. 2018). The European Shag breeding population estimate should also be considered with caution because their chicks had already fledged before the survey (del Hoyo et al. 2018), and the population size was estimated based on used nests. However, the total number of adults and juveniles encountered during the entire cruise (34 adults and 17 juveniles) supported the breeding pair estimation. At least two of the potential breeding colonies of European Shag were recorded on coastal cliffs on the mainland during the cruise. This emphasized the importance of coastal habitats for seabirds, which are under significant pressure because of coastal land reclamation for housing and road development in Turkey.

Two Scopoli's Shearwaters were observed during the coastal cruise, which coincided with their breeding period (del Hoyo et al. 2018). Scopoli's Shearwater may breed on islands and on mainland. However, their elusive breeding behavior and nocturnal visits to the nests in rock crevices, makes nest detection very difficult (del Hoyo et al. 2018). Scopoli's Shearwaters were previously observed during the breeding season along the Turkish coastline, specifically in the western Mediterranean and Aegean Sea regions (Kirwan et al. 2010). Breeding colonies were reported in the Greek Aegean Islands (EBCC 2022); however, no breeding colony has been found so far in the eastern Mediterranean region.

Table 7. Other (mostly terrestrial) avifauna of the eastern Mediterranean Islands. Abundance of birds are reported with the highest breeding codes in parenthesis. Suffix "o" represents the opportunistic counts out of survey transects and time.

	A1	A2	A4	A5	A6	A7	A8	A9	A10	A11	A12	A14	A17	A18	A21
Ruddy Shelduck (*Tadorna ferruginea*)	2 (Po)		6 (Po) o												
Short-toed Eagle (*Circaetus gallicus*)			1 (Po) o			1 (Po)									
Eleonora's Falcon (*Falco eleonorae*)			2 (Po)												
Peregrine Falcon (*Falco peregrinus*)														2 (Po)	
Eurasian Eagle-Owl (*Bubo bubo*)						1 (Po)									
Common Swift (*Apus apus*)			50 (Po)												
Alpine Swift (*Tachymarptis melba*)	5 (Po)	40 (C)			2 (C)	7 (C)	201 (C)	50 (Po)		1 (C)		154 (C)	50 (Po)	40 (Po)	10 (C)
European Roller (*Coracias garrulus*)			1 (Po) o												
Barn Swallow (*Hirundo rustica*)	1 (Po)														
Blue Rock-Thrush (*Monticola solitarius*)			1 (Po)		3 (Po)	1 (Po)									
Eurasian Blackbird (*Turdus merula*)				1 (Po)											
Rüppell's Warbler (*Curruca ruppeli*)			4 (Po)												
Western Rock Nuthatch (*Sitta neumayer*)			1 (Po) o		3 (Po)										
Hooded Crow (*Corvus cornix*)											2 (Po)				
Common Raven (*Corvus corax*)			1 (Po) o												

Fig. 2. Habitat types and their percent coverage on the islands. Small islands that were covered only by rocks and were not surveyed because of inaccessibility were excluded.



Therefore, it was not possible to determine whether Scopoli's shearwaters were foraging individuals from those colonies, or from a small Scopoli's Shearwater breeding population in the region.

Audouin's Gull breeding has been documented in the Aydıncık region since the 1970s. However, no extensive survey or monitoring of the breeding colony has been conducted to date (Ertan et al. 1989). The breeding colony size was reported as 28–30 pairs in 1997 (Yarar and Magnin 1997) and 17 pairs in 2001 (Çağlayan 2003). The present survey revealed a stable breeding colony size of 6–10 pairs between 2016 and 2023. The Audouin's Gull breeding colony nested on two different islands during the survey years. Prospecting behavior for

Table 8. List of dominant plant taxa on the islands. Islands lacking vegetation cover were excluded.

	A1	A2	A4	A5	A6	A7	A8	A9	A11	A12	A13	A14	A21
Ptilostemon spp.	X	X											
Ruta spp.	X				X								
Olea europaea	X	X		X	X	X			X	X		X	
Myrtus communis	X									X			
Ceratonia siliqua	X			X						X			
Helichrysum spp.	X												
Pinus burita			X										
Quercus spp.			X										
Santalum album			X										
Picea spp.			X										
Calicotome villosa			X	X		X							
Sarcopoterium spinosum				X	X	X							
Crithmum maritimum					X								
Chenopodium spp.							X	X					X
Heliotropium spp.							X	X					
Capparis spp.							X						X
Convolvulus spp.							X						
Malva spp.											X		X
Laurus nobilis										X			

alternating breeding site selection is commonly observed in seabirds (Kralj et al. 2023) and could reflect fluctuations in the pressures, e.g., number of predators, competition with other species for nesting site, and breeding success of a colony in a particular year (Ponchon et al. 2015). Overall, comparison of the current population size with historical reports revealed that the breeding colony has suffered a ~65–80% population loss in the last five decades. The dramatic decline observed in the Aydıncık breeding colony correlated with the trend in the Cyprus breeding colony, the only other Audouin's Gull breeding colony in the region. The Audouin's Gull breeding population in Cyprus experienced a decline of up to 37% between 2007 and 2015 (Hellicar 2016), with a population size of only 8–16 breeding pairs by 2015. Overall, ~14–26 Audouin's Gull breeding pairs in two colonies were still present in the eastern Mediterranean region east of 30.5° E, albeit with a dramatic historical population decline.

Fig. 3. Abundance and density of seabird nests on different habitat types estimated by transect surveys.

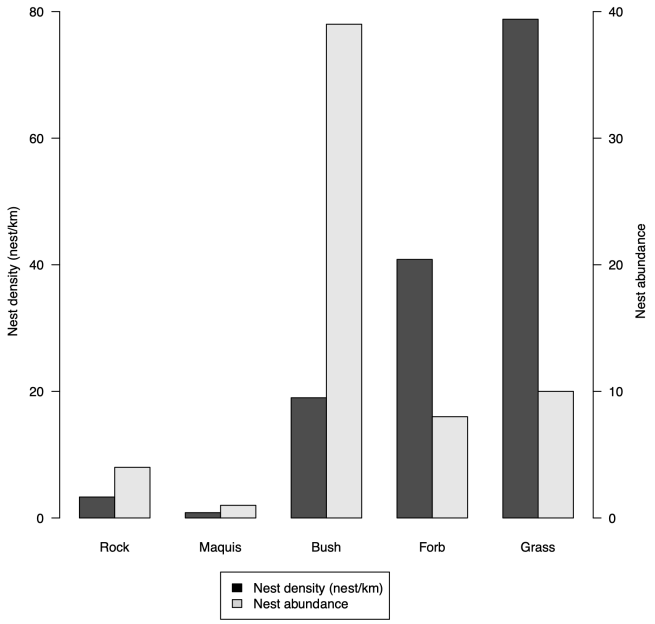
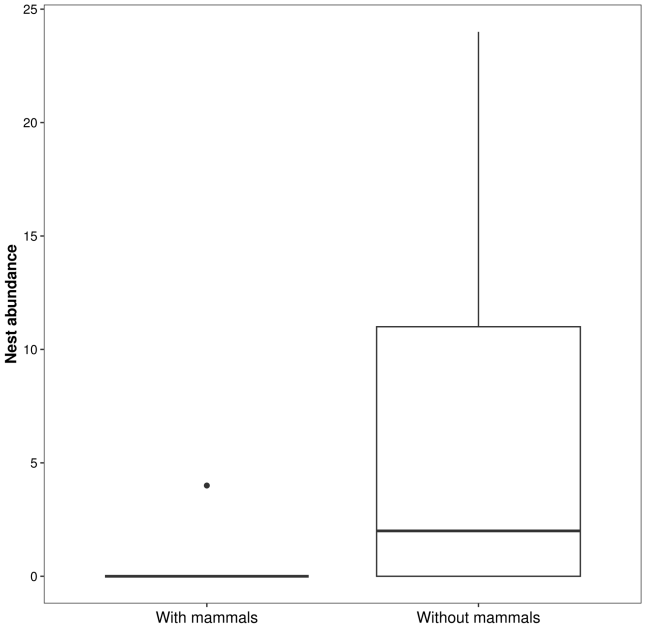


Fig. 4. Seabird nest abundance in 2016 on the islands with (n = 5) and without (n = 9) detected introduced rabbits and goats.



The corresponding decline in Audouin's Gulls breeding colonies in both the Aydıncık and Cyprus regions suggests that Audouin's Gulls in the eastern Mediterranean might also be experiencing similar pressures. Increasing foraging effort, interspecific competition, habitat degradation, and loss are some of the potential pressures previously documented for other colonies (Tavecchia et al. 2007). Although Audouin's Gulls may forage on fisheries discards (Pedrocchi Ruis et al. 2002), scattered observations in Croatia suggests a strong dependence of Audouin's Gulls on natural food sources (Jurinović et al. 2019). Breeding season, breeding habitats, and food sources of Audouin's Gull and Yellow-legged Gull are similar (del Hoyo et al. 2018), and interspecific competition between these two gull species has been widely documented (Arcos et al. 2001, Paracuellos and Nevado 2010) including kleptoparasitism and predation on Audouin's Gull eggs and chicks. The effect of kleptoparasitism on Audouin's Gull breeding success was reported to be limited in three western breeding colonies (Martínez-Abraín et al. 2003). However, the Audouin's Gull breeding colony in Aydıncık was very small and sympatric with a comparatively large Yellow-legged Gull breeding colony in a limited space, which may have exacerbated the negative effects of interspecific competition. Furthermore, islands hosting Audouin's Gull breeding colonies were used frequently as recreational fishing spots during the incubation period, and an illegal hut for fishing was constructed in Yılanlı Ada (A8) with abundant litter. Occasional adult, chick, and egg mortality were observed during the six years of Audouin's Gull monitoring, indicating that the remaining breeding colony was receiving pressures resulting in potential consequences in breeding success.

Although the highest seabird nest abundance was observed in bush vegetation, the highest seabird nest density was observed in herbaceous vegetation (grass and forb), which was also consistently preferred by Audouin's Gull breeding colonies on both islands. This suggests that habitats with herbaceous vegetation might be providing better nesting conditions for these gull species. The herbaceous habitat had only marginal cover on the islands and attained high coverage only on islands without evidence of rabbit or goat presence. A previous survey conducted on Audouin's Gull colonies on Aydıncık Islands (A10 and A11 in our study) in 2001 reported that these islands hosted forb and grass habitats without any indication of invasive mammal activity (Çağlayan 2003). However, we detected a high number of rabbits and two goats on Aydıncık's Büyük Island (A11) during our survey. Therefore, the islands in the region might have hosted more herbaceous vegetation before the 2000s, which coincided with potentially less invasive mammal abundance and a larger Audouin's Gull breeding population. Introduced rabbits and goats might have overgrazed the herbaceous vegetation on these islands (Reaser et al. 2007), promoted more grazing-adapted vegetation such as bush and maquis, which might be providing lower quality breeding habitat especially for Audouin's Gull. Furthermore, islands without invasive mammals tended to have a high number of seabird nests, suggesting a potential negative effect of invasive species on seabird breeding success (Reaser et al. 2007). However, the limited sample size in the present survey prevented us from reaching any firm conclusions. It should also be noted that the current methods did not allow detection of invasive rats and thus the reported invasive mammal activity is likely to be an underestimate of actual pressures. Occasional

observation of gull adult, chick, and egg mortality during the surveys further suggested the potential negative consequences of these pressures on seabird breeding success.

The islands also hosted diverse other (mostly terrestrial) avifauna; notably, a large breeding population of Alpine Swifts was observed on 11 islands. Karst geology of the islands resulted in abundant caves and cracks on rocks, creating suitable nesting habitat for Alpine Swifts. Furthermore, several raptor species with conservation priority were also observed, especially on the larger islands. The majority of the islands were not large enough to sustain resident raptor species, except for Dana Adası (A4). Therefore, these small islands might have served as safe breeding and resting grounds for raptor species with nearby foraging habitats on the mainland. It should be noted that the current transect survey methods could be insufficient to comprehensively account for all passerine and raptor bird species.

CONCLUSION

Here we present the first comprehensive survey on the breeding seabird populations as well as habitat structure and pressures along the eastern Mediterranean coastline of Turkey. We documented that the islands in this oligotrophic sea basin host significant breeding populations of Yellow-legged Gull and European Shag, and a small albeit stable (between 2016 and 2023) Audouin's Gull breeding colony. The comparison between historical records and current survey revealed that the single Audouin's Gull colony in the eastern Mediterranean coastline of Turkey has suffered a ~65–80% population loss in the last five decades. Habitat surveys revealed that seabird nest density was the highest in herbaceous vegetation, which might have been marginalized on the islands, potentially due to grazing by invasive mammals. We also documented several pressures on the islands hosting seabird breeding colonies, including anthropogenic pressures and invasive species, which likely directly or indirectly affected seabird breeding success. Our results emphasized an important need for (i) detailed studies on occurrence of invasive predators like rats and their effects on breeding seabirds, (ii) detailed assessment of overall human activities and causes of seabird mortalities, (iii) annual monitoring of breeding success of Audouin's Gull and breeding colonies of all seabirds on east Mediterranean islands, and (iv) limiting uncontrolled public access to seabird breeding colonies during the breeding period. Overall, urgent conservation-based management of these sensitive island ecosystems is needed.

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Data Availability:

All data are available in the manuscript.

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