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# Diversity and behavior of seagulls (Aves Laridae) along the beach between Tajura and Tripoli harbors, Libya

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**ABSTRACT** This study was conducted on seagulls (Aves Laridae) along the area between Tajura and Tripoli harbors (Northwest Libya) during the period from February 2021 to January 2022. aimed to study the diversity and abundance of gulls in the study sites, monitoring and documenting the intra-specific and interspecific behaviors, as well as to investigate the impact of some environmental factors on the diversity and the abundance of gulls. The study also addressed the relationship between the gulls and the fishermen. Regular four visits per month per site were conducted by using a telescope, binoculars and digital camera. For birds accounting, a point transect method was used. A total of 2775 specimens were counted belonging to nine species. This study recorded two rare species: Pallas gull *Larus ichthyaetus* and Great Black-backed gull *Larus marinus*. Moreover, three threatened species were recorded: Audouin's gull *Larus audouinii*, Slender-billed gull *Chroicocephalus genei* and Mediterranean gull *Ichthyaetus melanocephalus.* This study recorded a significant negative effect of temperature on the diversity and abundance of gulls. There was also a significant positive relationship between wind speed and the abundance of gulls in the morning times, whilst, the abundance during the evening was negatively affected by the humidity.

**KEY WORDS** Seagulls; Diversity; Abundance; Environmental factors; Behaviors.

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## NTRODUCTION

Libya, located in the north of Africa, overlooks the Mediterranean Sea with coastline extending approximately 2,000 Km (Azafzaf et al., 2006; Shakman et al., 2016; Zenati & Etayeb, 2021). The Mediterranean Sea holds significant ecological importance, serving as a critical habitat for marine biodiversity. Libya's waters are especially noteworthy, accounting for 36% of the southern Mediterranean coast (Shakman et al., 2016). This coastal region is characterized predominantly by sandy beaches (Hamza, 2022), with a mild climate a continental shelf that plays a crucial role in supporting marine ecosystems (Haddoud & Rawag, 2007). Libya's geographic location makes it an essential stopover for migratory birds, particularly water birds, as part of key international migratory routes. The country's coastal areas are recognized as important conservation zones for species such as seagulls (Aves Laridae), which migrate between breeding grounds in Europe and Asia and wintering sites in Africa (Ali, 2019). Many migration pathways originate in the Arctic region, underscoring the global ecological connectivity of Libya's coastal habitats (Deinet et al., 2015).

Seagulls, as migratory coastal waterbirds, play both environmental and economic roles along the coast. According to the African-Eurasian Agreement for the Conservation of Waterbirds, climate

change has impacted the distribution of the *Chroicocephalus genei* and affected the reproduction of several species, including *Hydrocoloeus minutus*, *Larus michahellis* and *L. ichthyaetus* (Nagy et al., 2022). Additionally, seagull mortality is significantly influenced by accidental bycatch in fishing gear (BirdLife DataZone, 2018). In Libya, the use of illegal and prohibited fishing methods is estimated to account for approximately 70% of fishing activities, causing severe damage to the marine environment (Shakman et al., 2014). This unsustainable fishing practice contributes to biodiversity loss and poses a significant threat to marine ecosystems.

Seagulls had been recorded in many previous studies and references, with one of the most important references on Libyan birds documented by Bundy (1976). However, Libya remained one of the least-studied countries for ornithology until 2005, when it signed several international agreements for the conservation of migratory birds. These agreements included the Ramsar Convention on Wetlands, the Convention on Biological Diversity, and the African-Eurasian Waterbird Agreement (AEWA). Since January 2005, Libya has participated in the annual winter counts for migratory birds. The waterbird counts have continued every January since then. Seagulls were consistently observed in good numbers during these counts, with findings documented in various scientific reports, including Azafzaf et al. (2005, 2006), Etayeb et al. (2007, 2015), IUCN (2011), Hamza et al. (2008), Bourass et al. (2013), and in publications such as the Wintering Atlas (EGA – SPA/RAC, 2012), Waterbirds in Northern Africa (Azafzaf et al., 2013), and The Birds of Libya (Isenmann et al., 2016).

Seagulls have been present in Libya since ancient times, but their reproduction was not recorded until later (Bundy, 1976). Reproductive activity of the *L. michahellis* was first observed in 1993 at various sites in eastern Libya (Meininger & Wolf, 1994) and later documented in western Libya in 1998 (Essghaier et al., 1998).

This study aims to gather environmental information about seagulls over an extended area between Tajura and Tripoli harbors, focusing on the following objectives:

• Check the diversity and abundance of seagulls in the study area.

• Investigating the relationship between seagulls diversity and abundance with environmental factors.

• Monitoring and observing seagull behavior.

## MATERIAL AND METHODS

### *Study area*

This study conducted on along extended area between Tajura and Tripoli harbor (13°24’38.9”E - 13°10’39.8”E), on the coastline next to sea on the Northwest of Libya, from the East to the West: Tajura harbor, Fishing port in Tajura, Spanish beach, Marine club port and Tripoli harbor (Fig. 1).

### *Samples*

Seagulls were studied at the specified sites over the four seasons. Each site was visited twice a day (morning and afternoon) for two days each month. The point-transect method was used to count seagulls, employing both direct counting and estimation techniques. Additional tools included a telescope and a camera for documentation. Temperature, humidity, and wind speed readings were obtained from the nearest meteorological stations to the study sites.

### *Data Analysis*

- Diversity Indicators: The PAST 4.03 program was used to calculate various indices, including the Dominance Index, Shannon Index, Evenness Index,

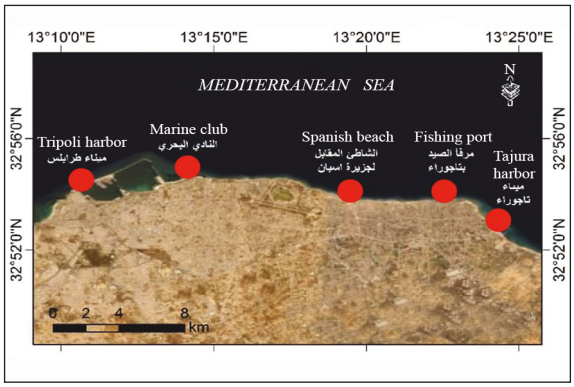


Figure 1. The study area: coast on the Northwest of Libya.

| Scientific name | N. |
|---|---|
| *Chroicocephalus ridibundus* (Linnaeus, 1766) Black-headed gull | 889 |
| *Chroicocephalus genei* (Breme, 1839) Slender-billed gull | 431 |
| *Ichthyaetus melanocephalus* (Temminck, 1820) Mediterranean gull | 702 |
| *Larus michahellis* J.F. Naumann, 1840 Yellow-legged gull | 100 |
| *Larus audouinii* (Payraudeau, 1826) Audouin's gull | 6 |
| *Larus fuscus* Linnaeus, 1758 Lesser black-backed gull | 642 |
| *Larus marinus* Linnaeus, 1758 Great Black-backed gull | 1 |
| *Larus ichthyaetus* Pallas, 1773 Pallas's gull | 2 |
| *Hydrocoloeus minutus* (Pallas, 1776) Little gull | 2 |

Table 1. The diversity and abundance of seagulls during the study period.

Species Richness Index, Relative Abundance, and Sorenson's Coefficient of Similarity.

- Statistical Analysis: The Chi-square test was conducted using SPSS version 24.

## RESULTS

### *Abundance*

This study recorded in the study area nine species of seagulls belonging to the family Laridae, with varying numbers observed across study sites and seasons. Tajura harbor exhibited the highest diversity, with eight species recorded, while the Spanish beach showed the lowest diversity, with five species ($P = 0.001$). Additionally, the winter season had the highest species diversity, whereas the summer season showed the lowest diversity ($P = 0.001$) (Figs. 2, 3)

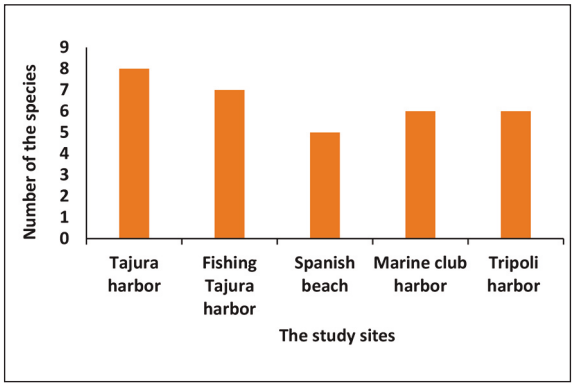


Figure 2. Diversity of seagulls in the study sites.

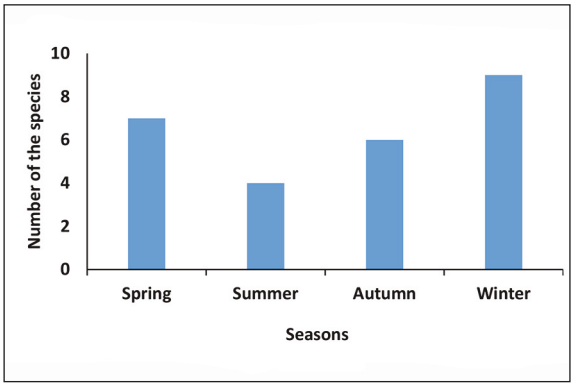


Figure 3. Abundance of seagulls through the seasons.

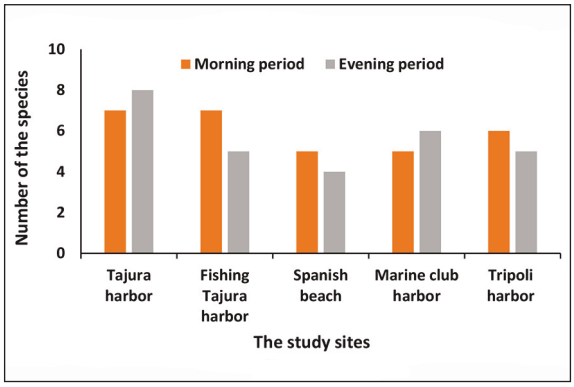


Figure 4. Diversity of Seagulls during morning and evening periods.

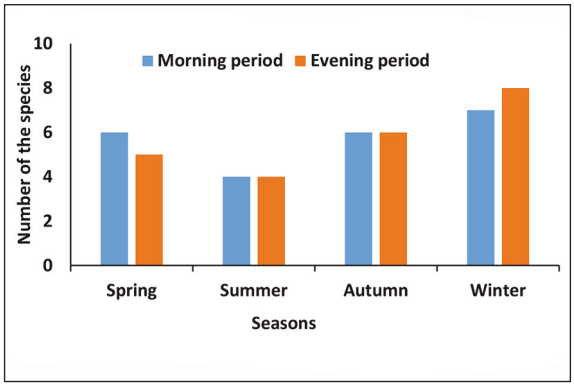


Figure 5. Diversity of seagulls during morning and evening periods through the seasons.

This study recorded significant difference between morning and evening periods in the diversity of seagulls at the study sites across the seasons (*P*=0.001) (Figs. 4, 5).

This study recorded 2775 seagulls specimens, with varying abundance between the sites during the study period (Table 1).

This study recorded a difference in seagull abundance between the morning and evening periods at each study site, with higher abundance observed in the morning. In the morning, approximately 2,729 specimens were recorded, compared to approximately 2,203 specimens in the evening (*P* = 0.001) (Fig. 6). Abundance also varied across seasons, with the highest number of specimens observed in the winter season (about 2,717 specimens) and the lowest in the summer season (about 126 specimens), which was a significant contrast (*P* = 0.001) (Fig. 7). Additionally, this study recorded seagull abundance in both the morning and evening periods across seasons and found significant differences in abundance between these periods during each season (P = 0.001) (Fig. 8).

The relative abundance of species in the study sites indicates that the highest abundance was recorded for *C. ridibundus* at 32%, while the lowest abundance was recorded for Great Black-backed gull, *L. marinus* (Fig. 9).

### *Environmental Indicators*

The highest value of the dominance index was recorded at the Tajura harbor area (0.33), while the lowest value was found at the Tripoli harbor area (0.25).

The highest value of the diversity index was observed at Tripoli harbor (1.50), while the lowest was recorded at Spanish beach (1.30).

The highest value of the evenness index was

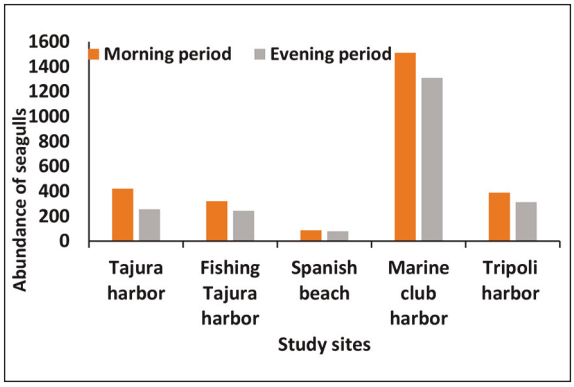


Figure 6. Abundance in morning and evening periods.

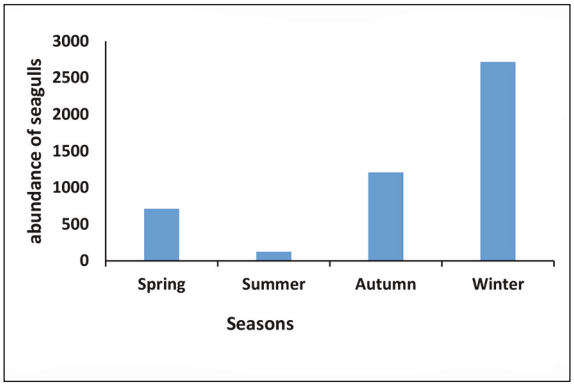


Figure 7. Abundance of seagulls during the seasons.

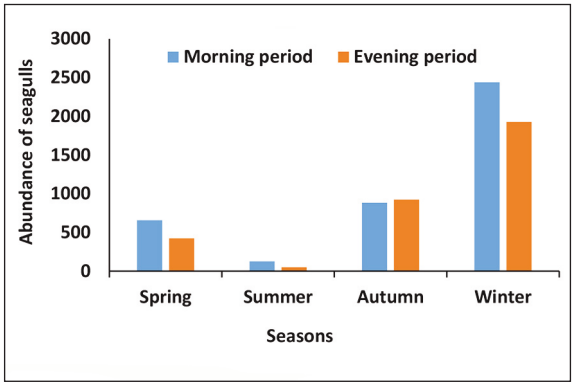


Figure 8. Abundance of seagulls during morning and evening periods through the seasons.

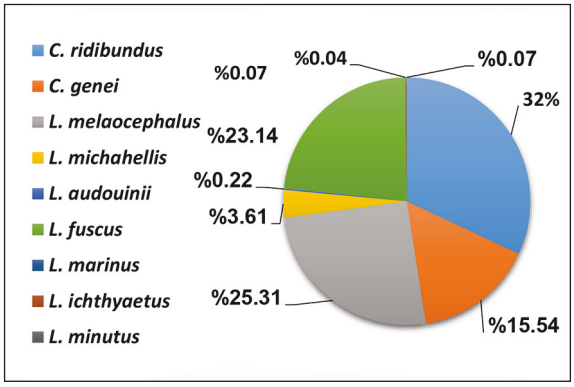


Figure 9. Percentage of seagulls abundance in the study area.

recorded at Tripoli harbor (0.75), whereas the lowest value was found at Tajura harbor (0.51).

The highest value of the Margalef index was recorded at Tajura harbor (1.15), while the lowest value was at the Marine Club Port (0.68).

The range of similarity between the study sites showed that the highest similar value was between Tajura fishing port and Tripoli harbor areas (92%), and the lowest similar value was between Tajura and Tripoli harbors about 71% (Fig. 10).

The Venn diagram between the study areas showed that all study sites were similar in 5 species, while Tajura harbor had only one specie which is Great black backed gull (Fig. 11). These species were present at all study sites: *C. ridibundus, Chroicocephalus genei*, *L. melanocephalus*, *L. michahellis* and *L. fuscus*.

The Venn diagram between the seasons showed that all seasons were similar among 4 species (*C. ridibundus, L. michahellis*, *L. audouinii* and *L. fuscus*), while winter season had two species: *L. marinus and H. minutus* (Fig. 12).

The study results showed that temperature had a negative significant effect on the diversity and abundance of seagulls, with an inverse relationship observed in both periods (P = 0.001 and P = 0.007, respectively) (Figs. 13, 14).

There was a significant effect of wind speed on seagull abundance, showing a positive relationship during the morning period (P = 0.009) (Fig. 15). Additionally, a significant effect of humidity on seagull abundance was observed, with an inverse (negative) relationship during the evening period (P = 0.001) (Fig. 16).

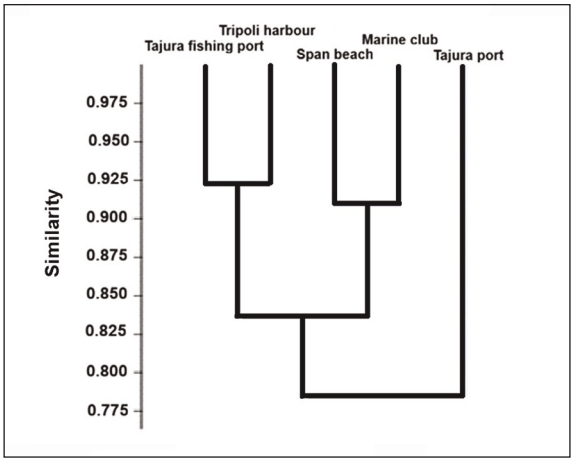


Figure 10. Cluster analysis of similarity between the study areas.

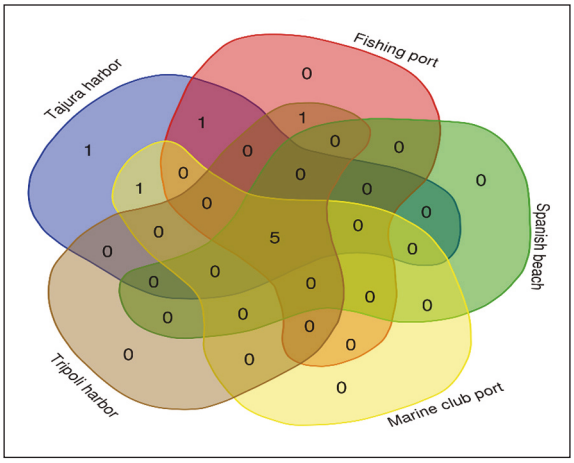


Figure 11. Results of Venn diagram among the study sites.

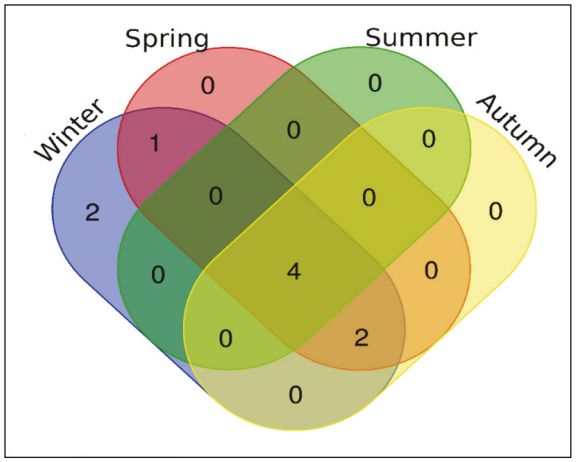


Figure 12. Results of Venn diagram among the seasons.

### *Protection*

During this study, two rare species - Great black headed gull *L. ichthyeatus* and Great black backed gull *L. marinus* - and three threatened species - Slender-billed gull *Chroicocephalus genei*, Mediterranean gull *L. melanocephalus* and Audouin's gull *L. audouini* - were recorded.

### *Behaviors*

During field visits and observations, different behaviors of the gulls were observed, including spatial behaviors, maintenance behaviors, various feeding behaviors, agonistic behaviors were recorded.

Additionally, this study observed courtship behavior in the Yellow-legged gull, *L. michahellis*, at the Tajura fishing port.

## DISCUSSION

This study highlighted the importance of Libyan beaches for migratory birds, especially seagulls, in the observed sites, particularly the Tajura harbor and Marine Club port. Tajura harbor exhibited the highest species diversity, with eight species recorded. The lack of significant human activity reduced disturbances to the seagulls, which are known to be negatively affected by such factors (Burton, 2007; Deinet et al., 2015; Tarakini et al., 2020). Notably, the Audouin's Gull, a species threatened with extinction (Lambertini, 1996), was recorded in this area, along with rare species such as the Great Black-backed Gull, previously observed on the western beaches of Tripoli (Zenati & Etayeb, 2021). In contrast, the Marine Club port demonstrated the highest seagull abundance, likely due to the availability of food and fishing activities, which may explain variations in seagull abundance between morning and evening observations.

Relative abundance analysis indicated that *C. ridibundus* had the highest overall abundance across the study sites. *Larus fuscus* showed the highest relative abundance and diversity during the winter, reflecting the seasonal migration of waterbirds to the southern Mediterranean (EGARAC/SPA, 2012; Etayeb et al., 2015). Conversely, *L. michahellis* dominated in summer, reaching up to 80% abundance, particularly in Tajura harbor, where the largest numbers were observed in spring and summer. This suggests that some specimens may remain for nesting along the Libyan coast (per-

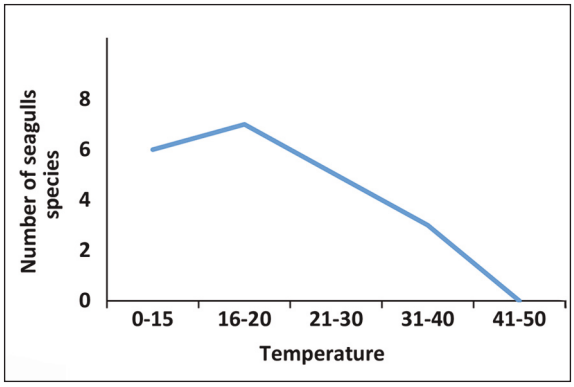


Figure 13. Temperature effect on the gull species.

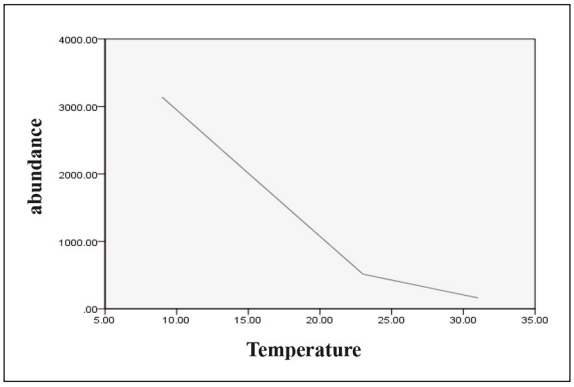


Figure 14. Temperature effect on the gulls abundance.

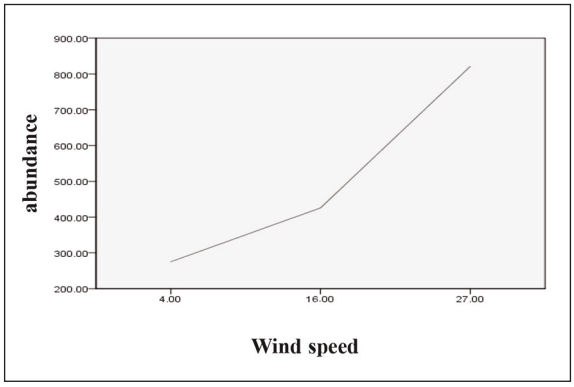


Figure 15. Wind speed effect on the seagulls abundance in the morning.

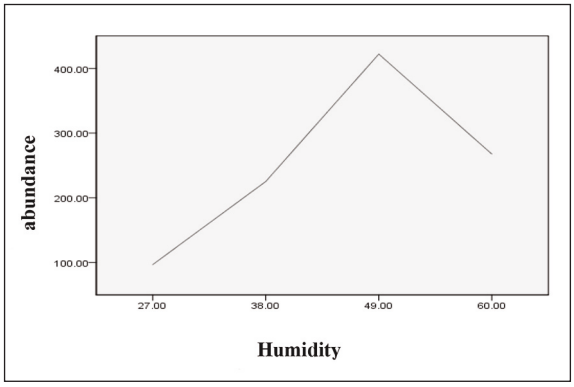


Figure 16. Humidity effect on the seagulls abundance in the evening.

sonal observations of nesting in Tajura harbor; Meininger & Wolfe, 1994).

During autumn, seagull numbers appeared more homogeneous, likely due to the arrival of migratory groups, while in other seasons, heterogeneity was observed, possibly due to variations in return migration timing for different species.

Seagull abundance was also influenced by environmental factors. High temperatures (Kirby, 2010; Deinet et al., 2015; Seri & Rahman, 2021) and high humidity led to avoidance behavior. Wind speed significantly affected their abundance in the study areas. As wind speed increased, seagulls tended to remain on the beach to avoid strong winds (Jennei & Steven, 2010).

Two rare species were recorded, including *L. ichthyaetus*, along with three species threatened with extinction. Among these, *L. genei* and *I. melanocephalus* are listed in Annex II of the Regional Activity Center for Specially Protected Areas (RAC/SPA). Additionally, *L. audouini* is listed on the IUCN Red List and Annex II (RAC/SPA – Annex II). The presence of these species underscores the importance of the study areas, highlighting them as significant biodiversity hotspots, particularly for birds (BirdLife International, 2009).

This study also monitored several behaviors of seagulls, including spatial behaviors and maintenance behaviors as body shaking and hoarding were observed, particularly in the early morning when temperatures dropped to around 11 °C. Additionally, various feeding behaviors and agonistic behaviors were recorded.

Some seagulls flying in coordinated groups to feed on fish, a behavior aimed at avoiding collisions (Kumar et al., 2021). Other behaviors, such as washing and drinking, were frequently recorded, particularly during midday and afternoon periods, as observed in the Mediterranean Gull (Zielińska et al., 2007). The study also revealed a diverse range of feeding behaviors and techniques, indicating a broad diet that contributes to their adaptability and ecological success (Shaffer et al., 2017). One notable observation was the behavior of some seagulls dropping stones from high altitudes onto mussels, similar to findings in European herring gulls, *Larus argentatus* Pontoppidan, 1763 (Gamble & Cristol, 2002). Agonistic behaviors included aggression among specimens of the same species, between different species of seagulls, and between seagulls and other water bird species. Aggressive behavior was most pronounced in the *L. michahellis*, which was identified as the most aggressive species (Etayeb & Essghaier, 2007).


Figures 17, 18. Courtship behavior for Yellolegged gull. Fig. 17: lowering the head. Fig. 18: lengthening the neck.

Courtship behavior in the Yellow-legged Gull (*L. michahellis*) was also documented (Gini, 1953) at the Tajura fishing port. The behavior included lowering the head while making noisy sounds, walking around the female, raising the chest, and extending the neck forward in an attempt to attract and win a mate (Figs. 17, 18).

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