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REPORT

# Report on coastal inspections for beached birds on Barreta Island from 2020 to 2023

Lisboa | October | 2024

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# Action D3 - Report of the project Ilhas Barreira.
# Report on coastal inspections for beached birds on Barreta Island from 2020 to 2023

SPEA


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**References**


Carvalho F., Nascimento T., Fagundes A.I., Timmer M., Oliveira N., & J. Andrade. 2024. Report on coastal inspections for beached birds on Barreta Island from 2020 to 2023. Action D3 report, Project Ilhas Barreira. Sociedade Portuguesa para o Estudo das Aves, Lisboa (unpublished report).

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# Summary

Coastal inspections for beached birds allow the collection of information on the spatial and temporal distribution of strandings and evaluate the causes of mortality. The main goals of this work is to identify the potential threats that seabirds are subject to, understand the occurrence of a temporal pattern of strandings and identify the possible cause of strandings and death.

Once a month, a 5.3 km transect was carried out to record all the beached animals on Barreta Island from May 2020 to July 2023, data were collected on species, condition and physical state, possible reason for the stranding/death, as well as environmental data.

In the 36 days of coastal inspections carried out throughout the study period, 709 seabirds were recorded. Seabird strandings averaged between 3.4 and 4.1 birds/km, with peaks in spring (5.0 ± 4.8 birds/km) and summer (5.3 ± 5.6 birds/km). Autumn had the lowest stranding rates (0.6 ± 0.7 birds/km). The Yellow-legged gull (N = 409) was the most stranded species, especially in spring (3.9 ± 3.8 birds/km), where 68% of stranded birds were adults. The Lesser Black-backed gull (N = 90) had higher strandings in winter (0.9 ± 0.7 birds/km), while Audouin's gull (N = 89) peaked in summer (2.3 ± 3.3 birds/km), predominantly consisting of juvenile birds. Notably, both Atlantic Puffins and Razorbills exhibited an increase in strandings, culminating in a significant mass stranding event in the country during the winter of late 2022 to early 2023.

In most cases (82%), the cause of death was unknown, as the state of decomposition was advanced in the majority of the birds found. For the remaining birds poor physical condition was evident in 15% of the strandings, with 3% of birds with evident malnutrition. Evidence of paretic syndrome was recorded in 8% of the cases, mainly affecting gulls. Signs of predation were registered in 6% of the stranded birds, but 80% of these records reported that the predation was post-mortem. Only in 6 birds the predation was considered to be the main cause of the stranding, being reported predation by cats and birds of prey. Around 1% of the individuals showed signs of bycatch in fishing gear, from which 1 Audouin's gull caught in a sport fishing hook, 5 Yellow-legged gulls, 1 Lesser Black-backed gull and 1 Northern gannet with evidences of capture by fishing nets, and 1 Yellow-legged gull with evidence of capture by longlines.

# 1 | Introduction

## 1.1 Seabirds strandings

A large number of marine wildlife, including seabirds, get to shore, dead or alive, every year in Portuguese continental coast (Costa *et al*., 2021). The purpose of monitoring these events is to collect information on the spatial and temporal distribution of strandings and evaluate the causes of mortality, which inform us of the variety of species and number of individuals that are vulnerable in a local area or region (Harden *et al*. 2006).
Seabirds are good indicators of the state of health of marine ecosystems and beached bird surveys can work as an early detection system for changes in ocean conditions. Poisoning, collisions, commercial fishing, predation by introduced species and hunting are some anthropogenic causes of bird mortality (Harden, 2002). Extreme weather conditions, oil spills, other types of pollution, accidental capture in fishing gear and a reduction in food availability have also been the main causes cited for the occurrence of massive seabird mortality events (Camphuysen *et al*. 1999, Clairbaux *et al*. 2021).

## 1.2 Causes of strandings

### Migration

Migratory birds undertake journeys covering thousands of kilometers, which can deplete their energy reserves, particularly if they encounter adverse weather conditions. Migration can thus place significantly physical demands on these birds, often leading to a decline in their condition. Common consequences of migration stress include malnutrition, muscle tissue loss, and overall exhaustion (Newton, 2008), and eventually strand on beaches or coastlines.

### Paretic syndrome

The Paretic syndrome in birds is associated with partial paralysis and weakness, muscular weakness, wing-drom, ataxia, diarrhea and flaccid cloaca" (Veloso Soares, 2014) resulting in an inability to fly or move. Causes such as toxin exposure, disease, physical trauma, or environmental stressors play key roles in the development of this syndrome. According to the report of RIAS, the wildlife recovery center in the Algarve region, most of the seabirds admitted, particularly gulls, were diagnosed with paretic syndrome (RIAS, 2021, 2022, 2023, 2024). Birds affected with the syndrome are more vulnerable to stranding and may drift ashore, exhausted, injured, or paralyzed contributing to strandings on beaches or coastlines.

## Predation

Seabird colonies, where birds nest in large numbers, are prime targets for predators, especially for ground-nesting birds. Predation is mainly made by mammals (e.g., foxes, rats, and cats) and other birds (e.g., crows and raptors), that attack eggs, chicks (Chokri *et al*., 2023)., but also adult birds. Injured birds may not survive the attacks and can end up stranded on beaches near the colonies.

## Bycatch

Entanglement in fishing gear and subsequent drowning is one of the major threats for seabirds, which is influenced by fishing practices, species´ abundance, biological traits and feeding behavior (Genovart *et al*., 2016; Cortés, Arcos, & González-Solís, 2017; Simpson and Fisher, 2017). Annually, at least 200,000 seabirds are bycaught in European waters (Ramírez *et al*., 2024).

Bycatch shows often a seasonal variation because it depends on a simultaneous presence of birds and fishery (Zydelis *et al*., 2009). Therefore, the numbers of bycatch are related to the breeding period of each bird species. Further variabilities in bycatch rates result due to different fishing gear that is used and environmental conditions like water clarity and meteorological conditions (Zydelis *et al*., 2009). Birds caught as bycatch in fishing operations can strand ashore dead or in a severe weakened condition.

## Weather conditions

Especially migratory birds are vulnerable to the severe weather conditions like strong winds, which can throw them off course or disorient them, and cold fronts that can cause hypothermia or starvation due to lack of food availability. Storm can lead to mass mortality, induced either during the flight or due to disadvantageous weather-related conditions after arrival in or before the departure from breeding areas (Newton, 2007). Unsuitable weather conditions in breeding areas can change food supply and may delay the departure after the breeding season (Newton, 2007). Due to global climate change, extreme weather events are more likely to occur. Therefore, an increase in mortality and decrease in breeding success due to harsh conditions is possible (Wingfield, 2017).

## Breeding conditions

During the breeding season, seabirds face unique challenges with increase in the energy expenditure used in mating, building the nest, incubation and feeding the chicks. If food sources are scarce or far from breeding colonies, birds may become overworked and deplete their energy reserves. Also, while on land they are more exposed to predators that can injure or weaken them (Chokri *et al*., 2023). Close proximity in breeding colonies can also lead to the rapid spread of diseases, such as avian influenza or avian botulism.

All these factors can be physically taxing and birds may become more vulnerable and weakened that can lead to exhaustion, injury, or death, causing them to strand on beaches and coastal areas.

## 1.3 LIFE Ilhas Barreira project

The barrier islands are a unique system in Ria Formosa that support priority habitats such as fixed dunes “grey dunes”, essential for the stabilization of dune and protection of the shoreline, the presence of interesting floristic species, and priory bird species.

Ria Formosa is home to 4 breeding seabirds: Audouin’s Gull (*Larus audouinii*), Little Tern (*Sternula albifrons*), Yellow-legged Gull (*Larus michahellis*) and Lesser black-backed gull (*Larus fuscus*). Main biodiversity threats are related to huge touristic pressure, especially during the summer months, bycatch and mortality in fishing gears, and the presence of invasive alien mammals (rats and cats) on the islands.

The LIFE Ilhas Barreira project aims to characterize the local ecological requirements and conservation threats of the target species and habitats in Ria Formosa, and particularly at Barreta Island, to implement effective conservation actions. With the aim of understanding the main threats to seabirds both on land and at sea, monthly coastal inspections were conducted along the shoreline of Barreta Island for prospecting beached birds and determine causes of mortality.

## 1.4 Aims of the monitoring

The monitoring of stranded seabird was used to detect changes in the terrestrial and marine habitats, to determine the potential threats to these group of animals and to inform an action in case it was needed. Detailed information on the spatial temporal variation was collected. The identification of the possible cause of death was also an important aim of this monitoring.

# 2 | Methods

## 2.1 Study area

Barreta Island, also known by Deserta island, is one of seven islands and peninsulas that form a barrier between sea and land at the south coast of Portugal (Fig.1). This lagoon system and the barrier islands are part of the Ria Formosa Natural Park (created in 1987). The area is a wetland of worldwide interest since 1980 (Ramsar, 2022). This ecosystem – stretching from Ancão to Manta Rota – includes a wide variety of habitats: barrier islands, salt marshes, sand banks and mudflats, dunes, salt marshes, fresh and brackish water lagoons, courses of water, agricultural areas and forests, contemplating a great biodiversity (ICNF). It was identified as Important Bird Area and classified as part of Natura 2000 Network since 1988. It protects 121 species and 19 habitats listed in the Habitat Directive. In addition to being a wintering area, it also serves as an important stopover during bird migration.

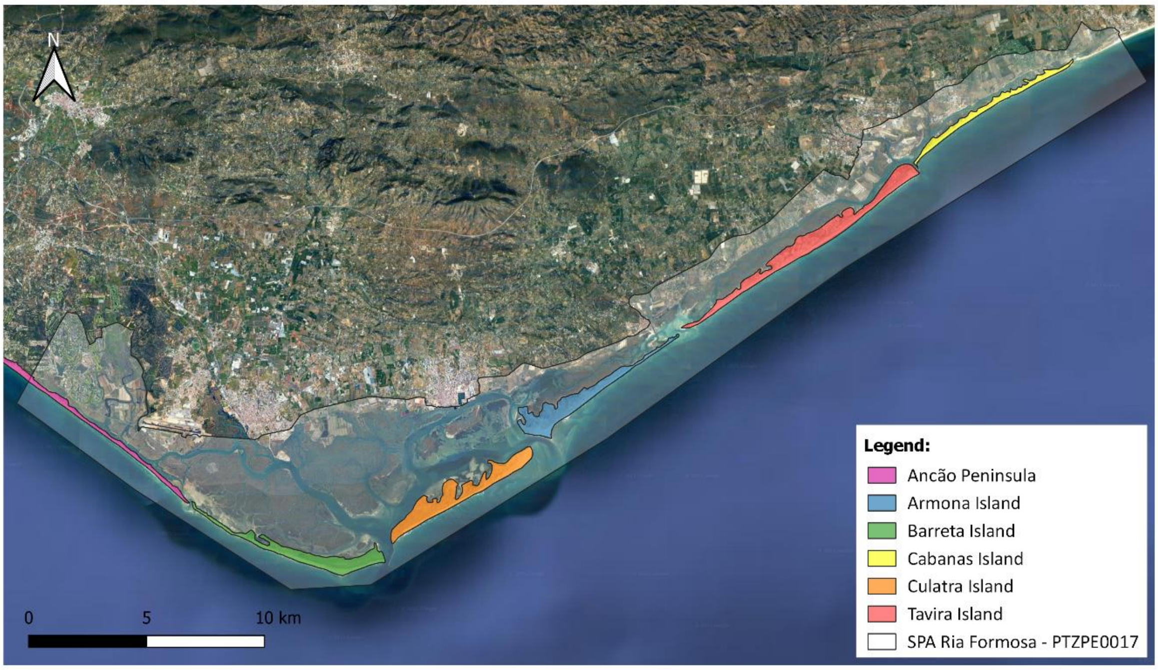


**Figure 1** | Map of the location of Ria Formosa SPA and the barrier islands, on the Algarve coast.

## 2.2 Data collection

From May 2020 to July 2023, once a month (excepting August) a line transect covering 5.3 km of the sandy south coast of Barreta Island (near two thirds of the coastal line facing the sea) was sampled (Fig. 2). Two to three people walked along this transect at low speed and in low tide in order to detect and count all stranded animals. Each transect took an average of 2h15 to be covered.


**Figure 2** | Transect performed during coastal inspections in Barreta island for detecting stranded seabirds.

Data on species, number of animals, condition, physical state and fate (Table I) was recorded. In addition, the possible reasons for stranding or death were noted, including, hydrocarbons, petroleum, fishing gear, other chemicals, predation, non-traumatic origin (dirty cloaca), gunshot, malnourished/poor physical condition and others. The keel was assessed to estimate the physical condition of the bird. Detailed information about indication of incidental catch in fishing gear was collected as well as coordinates of the location of the stranded animal. Information of other stranded group species was also collected, namely marine mammals and sea turtles. Environmental details were also recorded, including time of last beach cleaning if any, sea level, presence of visible lines, number of people and dogs, wind force and sea state. In addition, the amount of wood, fishing gear and other materials present along the beach was noted.

The transect was started at the furthest point from the port, allowing that if we came across a live stranding, the remaining transect would be shorter, which allowed the reduction of stress and increased the probability of the animal's survival. If a seabird was found alive (Fig. 3c), in a poor condition or injured, it was collected and delivered to the ALDEIA/RIAS recovery center in Olhão. Freshly dead birds (Fig. 3a and 3b) were also delivered for later necropsies in order to identify the potential cause of dead. If the animal had been dead for longer or had only remains (Fig. 3d), it was left on the beach.

Data was split by season. Surveys ran from January to March were assigned as winter, from April to June as spring, from July to September as summer and from October to December as autumn. The number of stranded individuals was normalized by the sampling effort (birds per kilometer). Additionally, individuals were classified by age group and species.

Non-parametric tests were used due to the non-normal distribution of the data, as determined by the Shapiro-Wilk test ($p < 0.05$). A Kruskal-Wallis test was applied to assess differences in the number of stranded individuals among different species and age groups across years and seasons. Post-hoc pairwise comparisons were performed using Dunn's test with Bonferroni correction to identify specific differences between species and age categories. Kruskal-Wallis tests were also used to evaluate the variation in stranded individuals across different years and seasons for each species. When significant differences were found, Dunn's post-hoc test was employed to identify which years or seasons differed significantly. All analyses were performed using the R software (version 4.4.0), with the FSA package for non-parametric tests. Results were considered statistically significant at $p < 0.05$.

**Table I** | Categories used to record the status and fate of the birds found during coastal inspection on Barreta island.

| | State of the bird | Animals's fate | Physical state |
|---|---|---|---|
| 0 | Alive, in good condition | Delivered to a recovery centre | Round keel (good physical state) |
| 1 | Alive, in poor physical condition | Collected by environmental agents | Flat keel (average physical condition) |
| 2 | Injured | Removed from the beach (destination unknown) | Concave keel (bird in poor condition) |
| 3 | Dead<br>< 1 week (whole body, dry and with eyes, the species is well identified) | Abandoned on the beach | Poor condition of the bird does not allow the keel to be determined |
| 4 | Dead<br>< 1 week (whole body, dry and without eyes, the species is well identified) | unknown | unknown |
| 5 | Dead<br>> 1 week (body in decomposition, falls apart when handled, difficult to identify) | | |
| 6 | Dead<br>indefinitely (only body parts, cannot be identified for sure) | | |

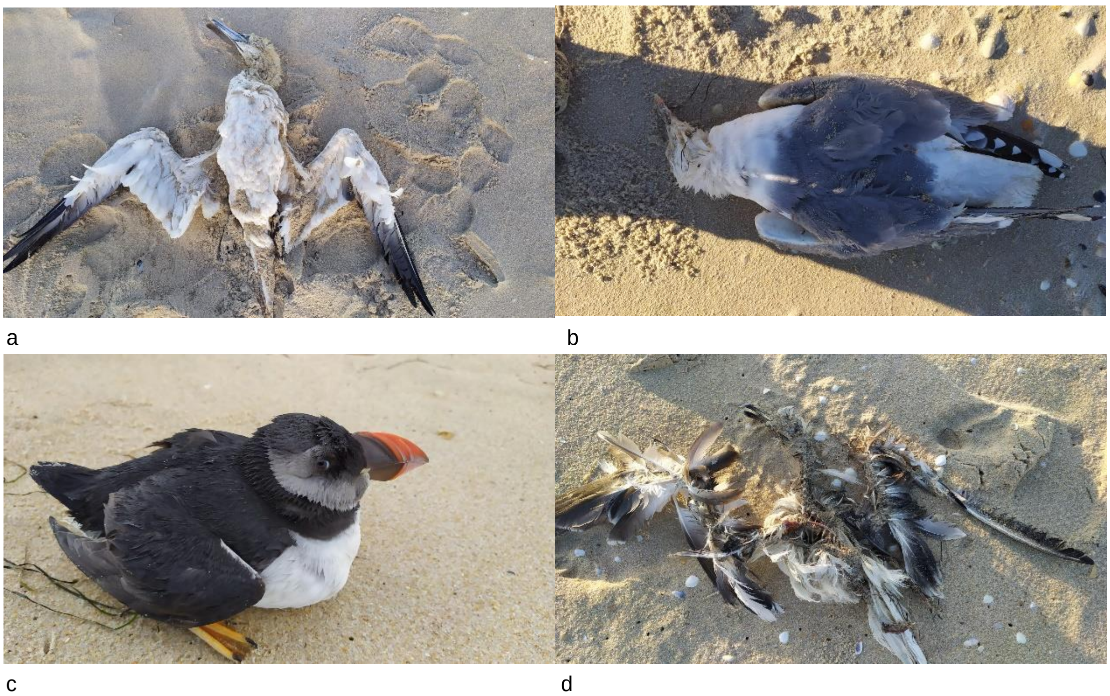

**Figure 3** | Stranded seabirds with different physical states found on Deserta/Barreta Island. a: Northern gannet *Morus bassanus* dead (<1week), b: Yellow-legged gull *Larus michahellis* dead (<1week), c: Atlantic puffin *Fratercula arctica* alive, d: Lesser black-backed gull *Larus fuscus* dead (>1week), only body parts.

# 3 | Results

A total of 709 stranded seabirds were recorded on Barreta Island during the stranding surveys (Table I). No significant differences were found between years ($p = 0.54$), although 2023 was the year with the highest number of stranded seabirds per km (N = 4.1). Some monthly variation was noted (Fig, 4), with the largest numbers of strandings in 2020 occurring in May (N = 53) and July (N = 38). Even more pronounced peaks were recorded in 2021, with 84 strandings in April and 79 in July. The strandings in 2022 were more evenly distributed across January, February, March, May, and July. In 2023, April had the highest number of strandings (N = 47).

In summary, the spring (5.0 ± 4.8 birds/km) and summer (5.3 ± 5.6 birds/km) seasons had the highest average number of stranded seabirds, while autumn (0.6 ± 0.7 birds/km) recorded the fewest strandings (Fig. 6). The difference between seasons was significant ($p < 0.01$) between Autumn and all the remaining seasons (Autumn-Spring: $p = 0.01$; Autumn-Summer: $p = 0.04$; Autumn-Winter: $p = 0.01$), but not between spring, summer and winter comparisons.

**Table I** | Characterization of the sampling effort per year and the number of stranded birds per km.

| | 2020 | 2021 | 2022 | 2023 | Total |
|---|---|---|---|---|---|
| **Number of days** | 6 | 12 | 11 | 7 | 36 |
| **Total number of km inspected** | 31.8 | 63.6 | 58.3 | 37.1 | 190.8 |
| **Total number of seabirds detected** | 108 | 238 | 211 | 152 | 709 |
| **Seabird/km** | 3.4 | 3.7 | 3.6 | 4.1 | - |

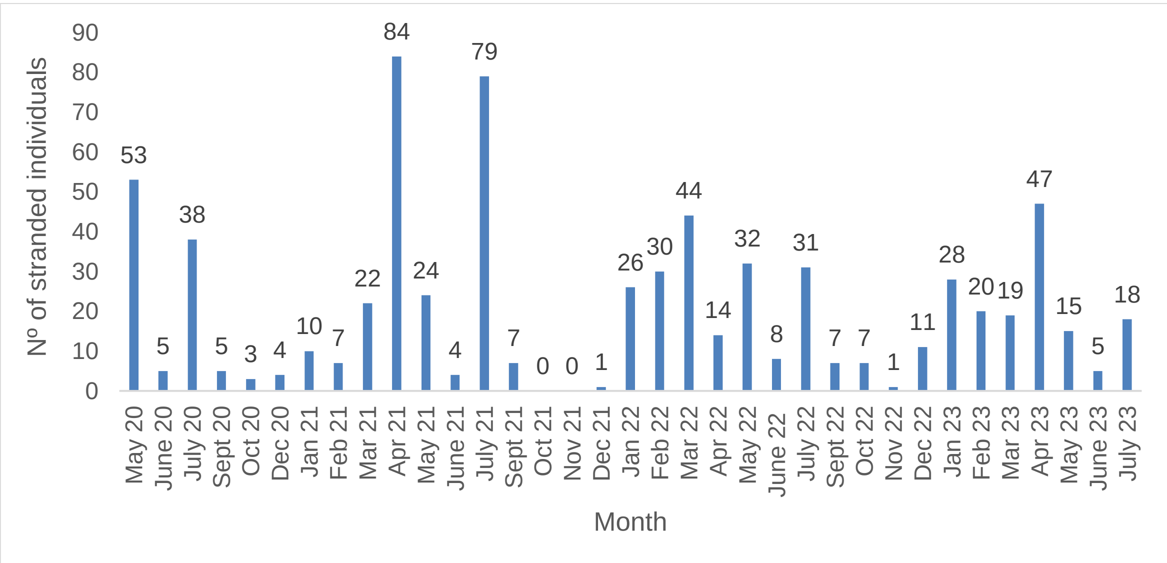


**Figure 4** | Number of stranded birds per month from May 2020 to July 2023. Same monitoring effort (kms monitored) was conducted each month

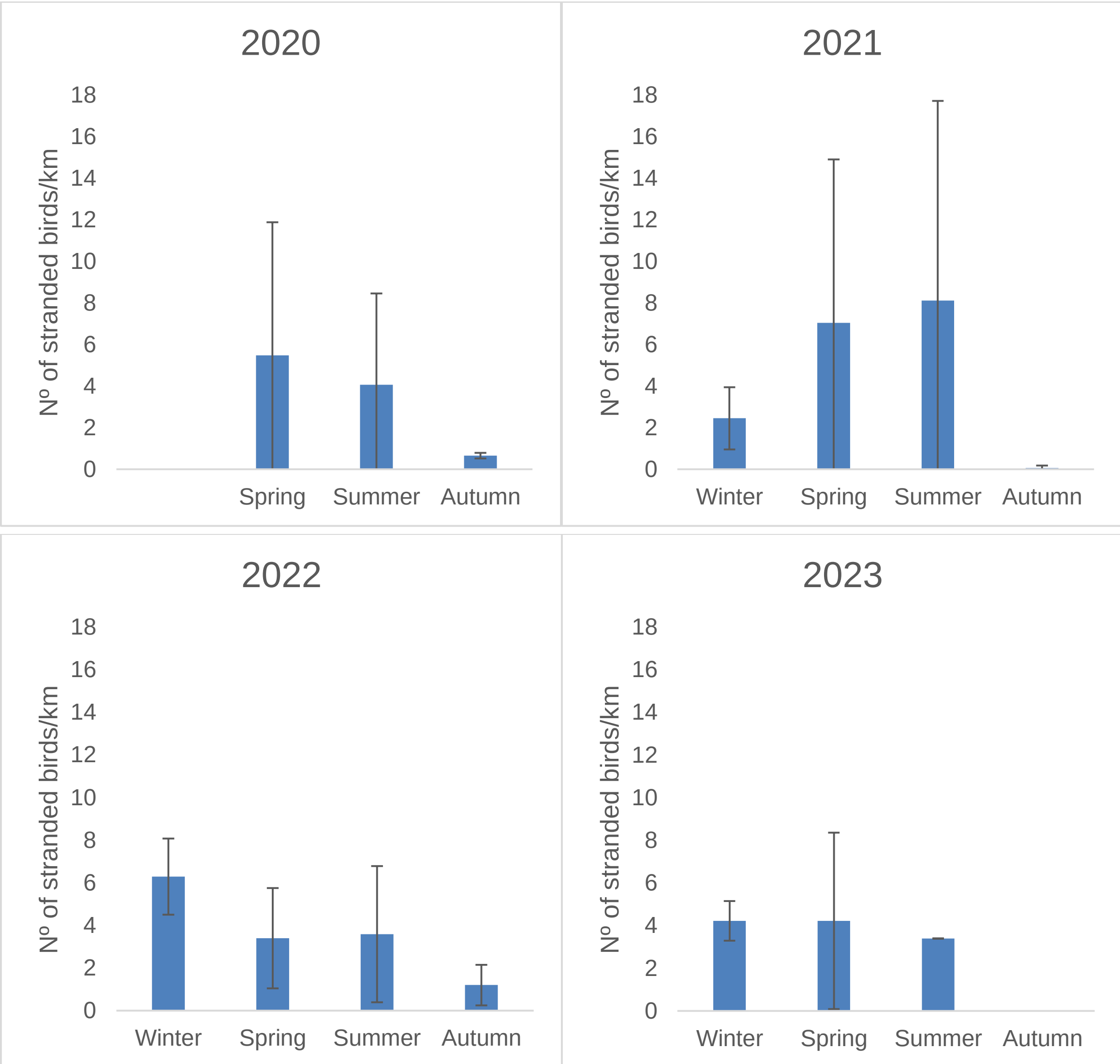


**Figure 5 |** Number of stranded birds per kilometer monitored in each season in the years of 2020 to 2023.

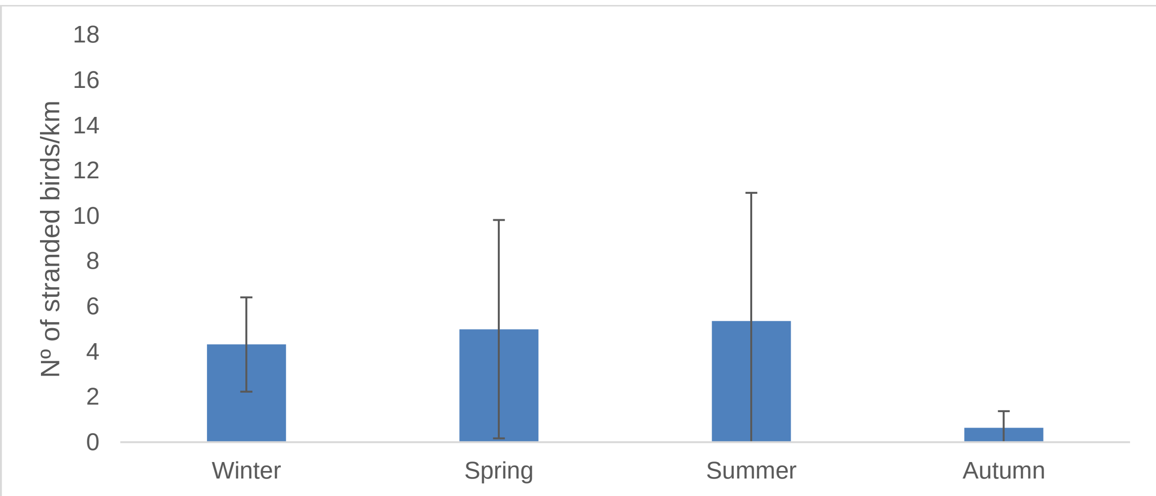


**Figure 6 |** Average and standard deviation of the number of stranded birds per season.

Gulls had the highest number of strandings (Fig. 7). The Yellow-legged gull was the most frequently recorded species (N = 409), with a peak during spring (3.9 ± 3.8 birds/km). Significant differences were recorded between seasons ($p < 0.01$), but not between years ($p = 0.67$), with the number of stranded Yellow-legged gulls being significant less in Autumn than in Spring ($p < 0.01$) and Winter ($p = 0.02$).

For the Lesser Black-backed gull (N = 90), greater numbers were registered in Winter (0.9 ± 0.7 birds/km), being significantly higher when compared with Autumn ($p = 0.04$). No significant differences were registered between years.

The Audouin's gull also had notable strandings (N = 89), peaking in Summer (2.3 ± 3.3 birds/km), with significant differences between seasons ($p = 0.02$), and when comparing Summer with Autumn ($p = 0.02$).

Among other recorded species (Fig. 8), the Atlantic puffin (*Fratercula arctica*) had the highest number of strandings (N = 18), all of which occurred in the early months of 2023, primarily during winter (N = 15). The number of strandings was not significant different between seasons ($p = 0.32$), but was between years ($p < 0.01$), with stranding events only happening in 2023.

The Razorbill (*Alca torda*) also showed increased strandings at the end of 2022 and beginning of 2023 (Fig. 10), with the majority recorded in Winter (N = 13), but with no significant differences between seasons ($p = 0.09$). The strandings were significantly higher in 2023, when compared with 2020 ($p = 0.04$) and 2021 ($p = 0.01$).

Sanderling (*Calidris alba*), Band-rumped Storm-petrel (*Hydrobates castro*), Northern Gannet (*Morus bassanus*), Great Cormorant (*Phalacrocorax carbo*) and Balearic Shearwater (*Puffinus mauretanicus*) were also recorded but in lower numbers (Fig. 8). It was not possible to identify 16 stranded seabirds and for 50 birds it was only possible to identify up to the genus *Larus*.

In addition to seabirds, during the periodical inspections, 10 sea turtles (loggerhead sea turtle *Caretta caretta*), 4 cetaceans (2 common-dolphins *Delphinus delphis*, 1 bottlenose dolphin *Tursiops truncatus* and 1 striped-dolphin *Stenella coeruleoalba*) and 1 shark were also recorded.

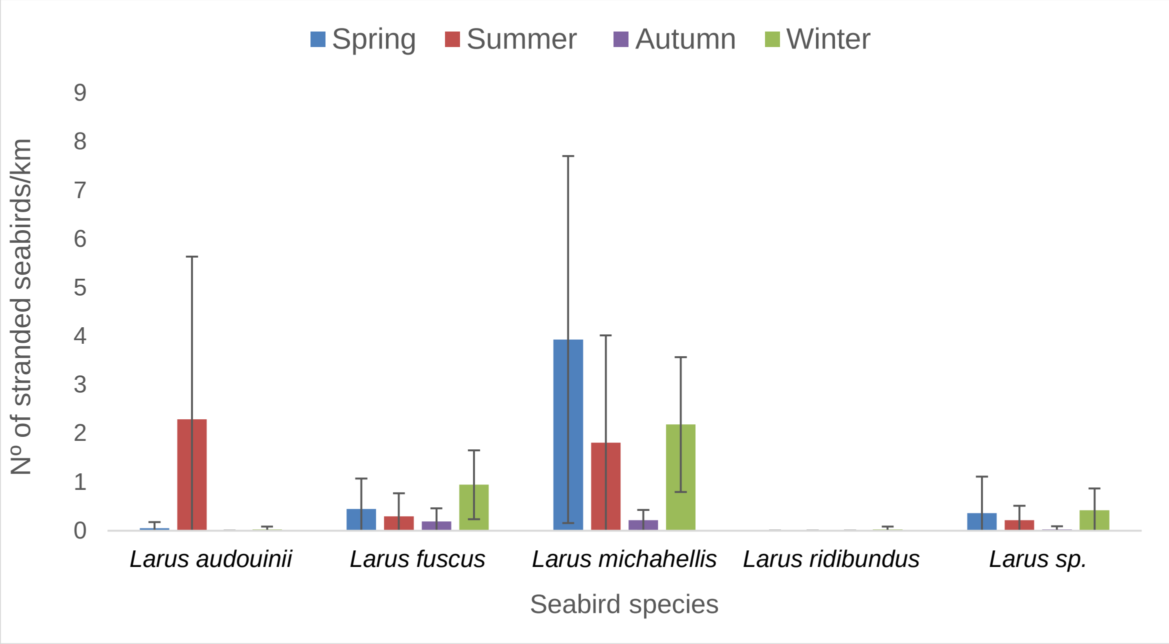


**Figure 7** | Average and standard deviation of the number of stranded seagulls per km and by season.

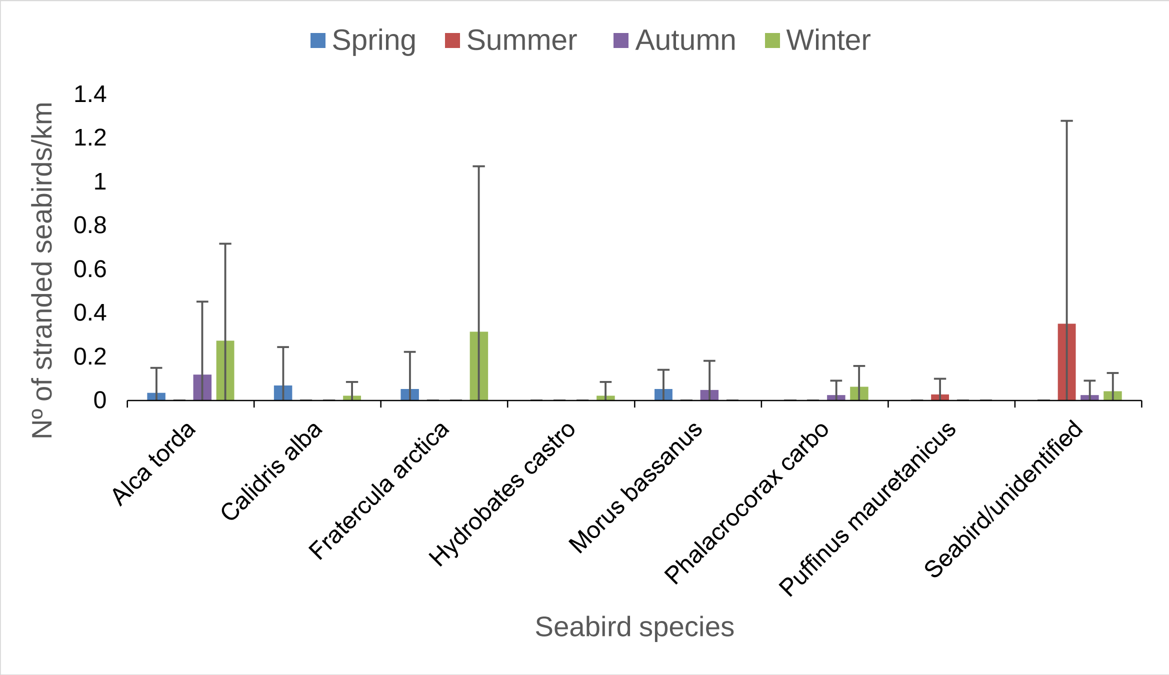


**Figure 8** | Number of stranded bird species other than gulls, per km and by season.

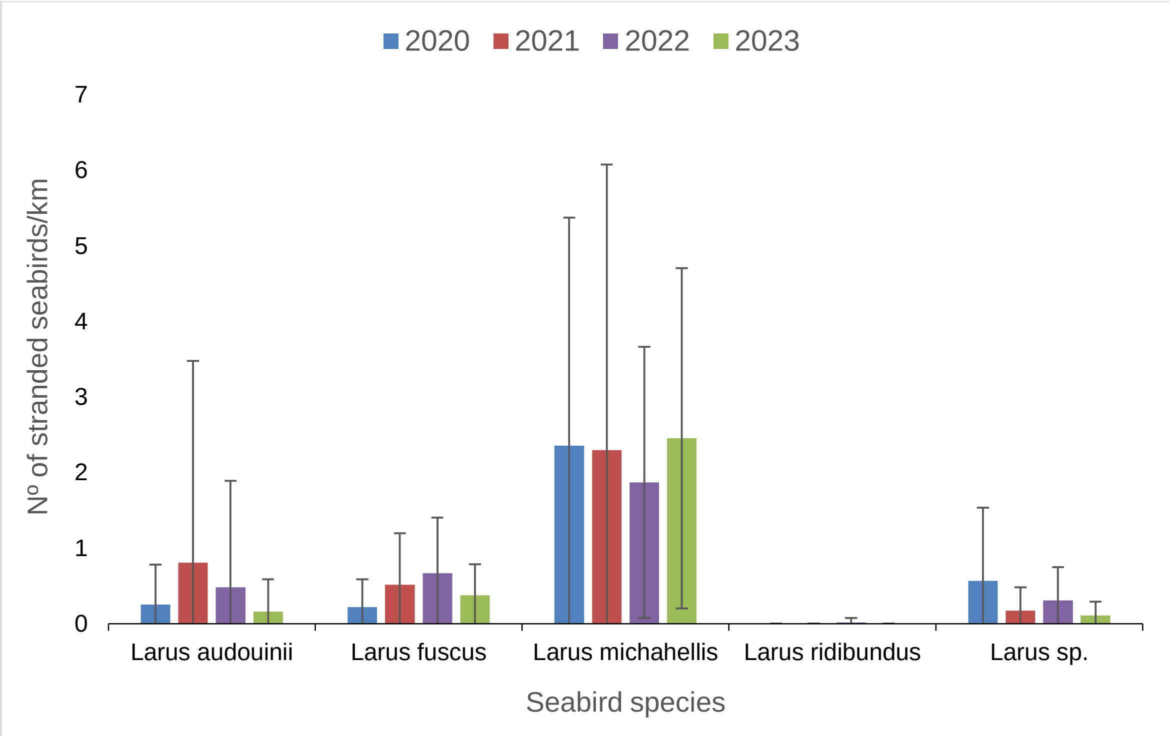


**Figure 9** | Number of stranded seagull species per year.

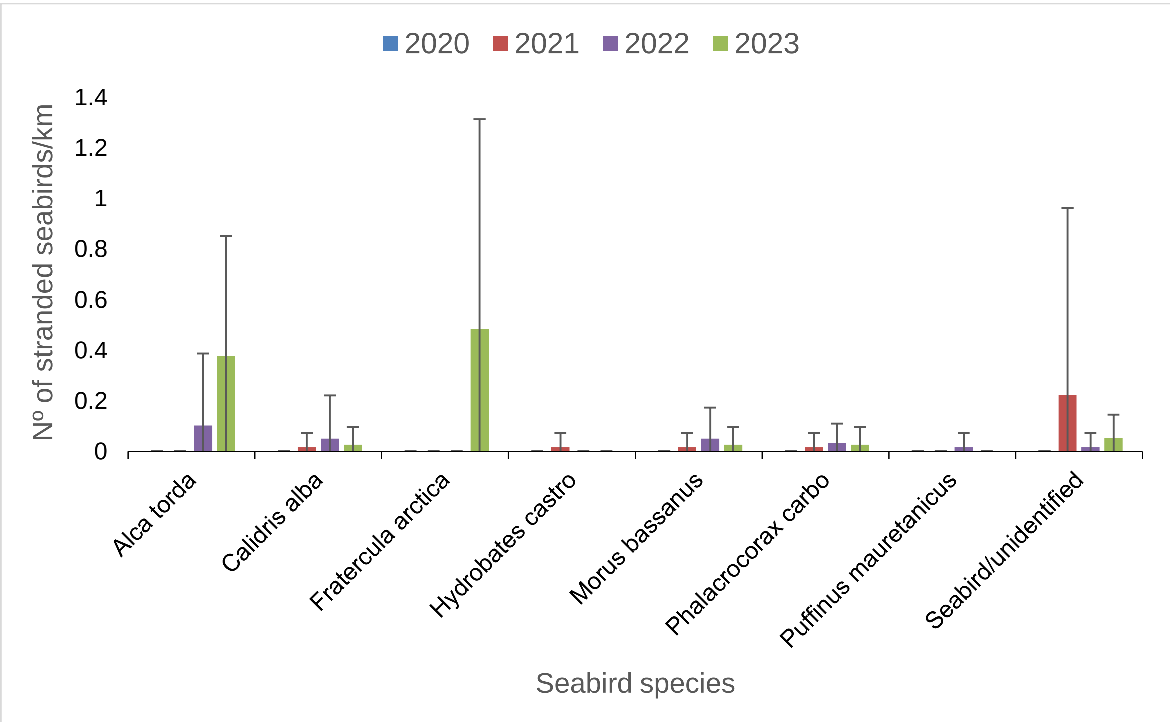


**Figure 10** | Number of other stranded bird's species per year.

## 3.1 Species and age distribution of stranded gulls

Out of the 638 records of gull strandings, 409 were of Yellow-legged gulls (Fig. 11). The majority of strandings were of adults (68%) in all four seasons (Fig. 12). Immatures were recorded more during Winter, and juveniles in Spring (Fig. 12).

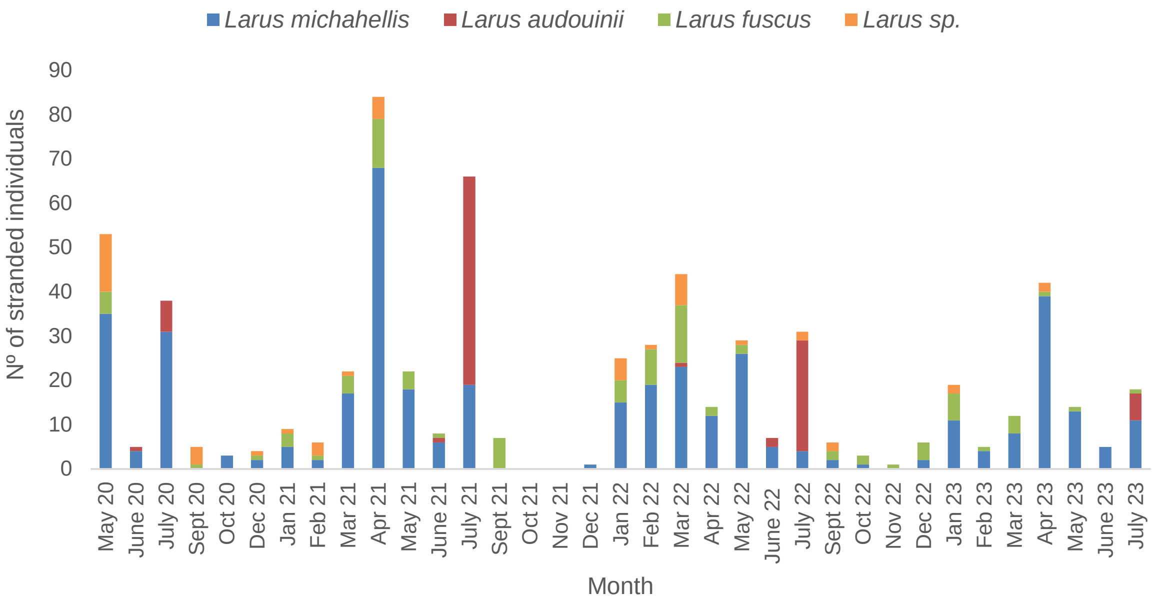


**Figure 11 |** Total number of stranded gulls per month divided into gull species. Blue: yellow-legged gull, red: Audouin's gull, green= lesser black-backed gull, orange: unidentified gull.

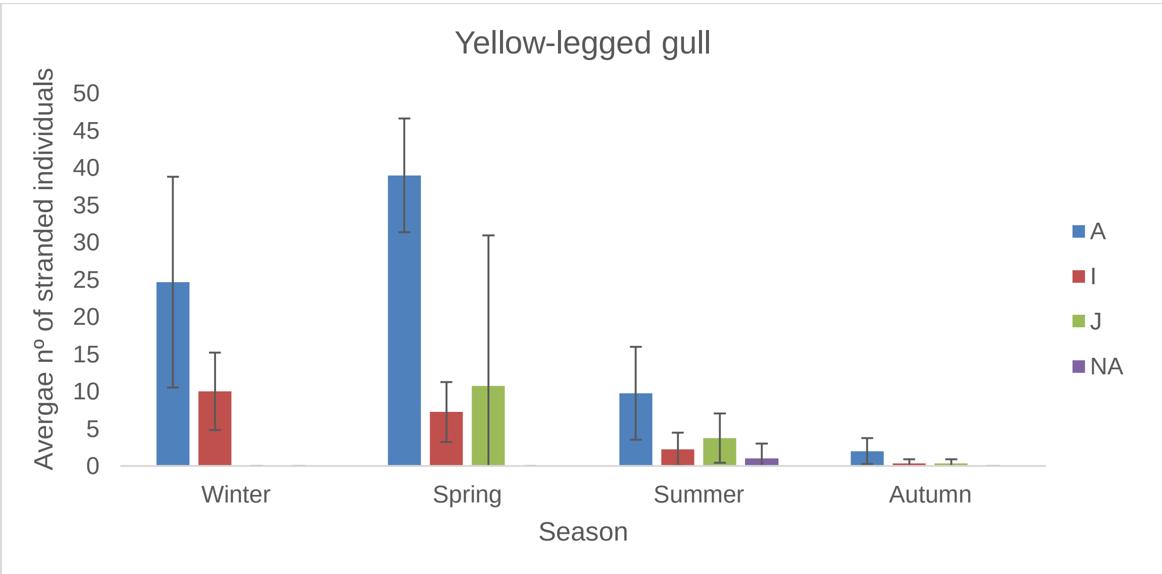


**Figure 12 |** Average number of stranded individuals of Yellow-legged-gull divided by age per season, blue: A = Adult, red: I = Immature, green: J = Juvenile, orange: NA = age not recorded

For Audouin's gulls the majority of strandings events occurred during summer (Fig. 13), with juveniles representing the vast majority of strandings (19.3 ± 20.8), with a special incidence in the month of July (Fig. 11)

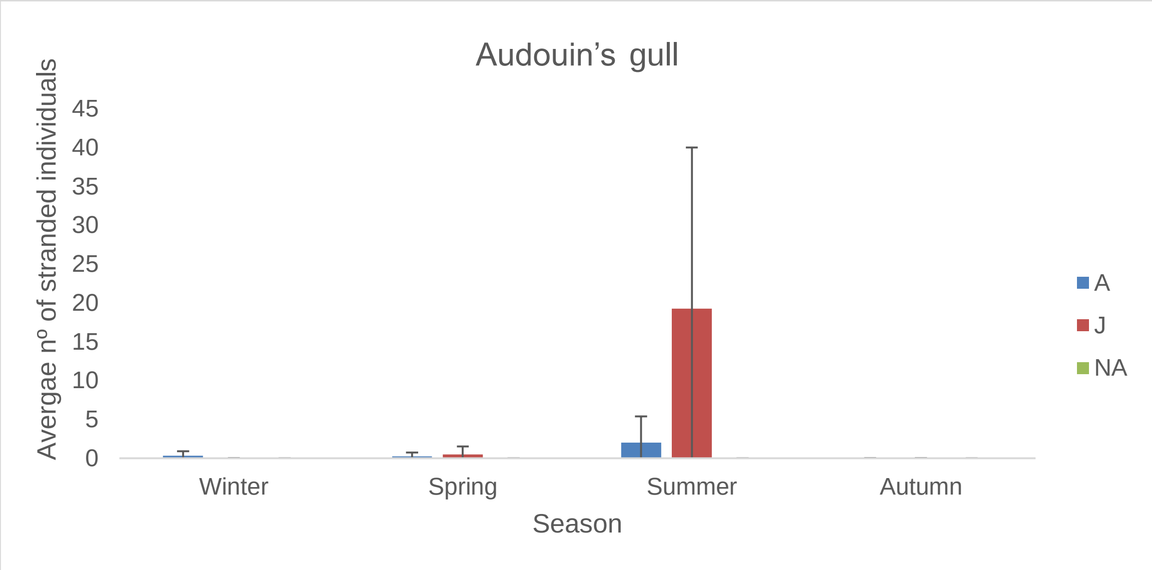


**Figure 13** | Average number of stranded individuals of audouin's gull divided by age per season, blue: A = Adult, red: J = Juvenile, green: NA = age not recorded

In total 90 stranded individuals of Lesser black-backed gull were recorded. Stranding events occurred mainly in adults (60%), with more records in Winter (Fig. 14). Immature individuals were recorded also more frequently in winter. In case of juveniles strandings the highest numbers were recorded in Spring.

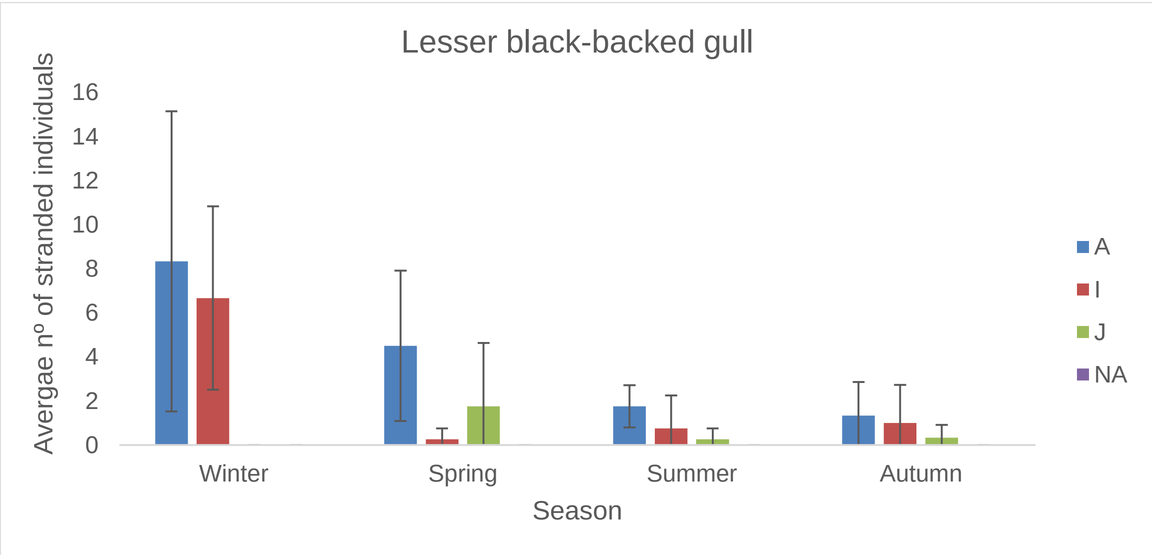


**Figure 14** | Average number of stranded of lesser black-backed gulls divided by age per season, blue: A = Adult, red: I = Immature, green: J = Juvenile, orange: NA = age not recorded

## 3.2 Causes of stranding

Most of the stranded birds found were dead (92%), only 53 individuals (8%) were found alive with good, bad conditions or injured (Table II). In total 48% of birds were dead for over a week, approximately one third (29%) were dead less than a week, and 16% with date of death unknown. In relation to the fate given to the birds found, most of the stranded birds (94%) were abandoned on the beach, 21 live birds (39% of the total number of stranded live birds) in poor condition/injured were delivered to the recovery center for rehabilitation and 11 dead birds (2% of the total number of stranded dead birds) were delivered to the recovery center for necropsy.

**Table II** | Number of stranded individuals per family by their condition, with total and %.

| Condition | Number of individuals per family | | | | | | | | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|
| | Alcidae | Hydrobatidae | Laridae | Phalacrocoracidae | Procellariidae | Sulidae | Scolopacidae | Unknown | | |
| **alive, in good conditions** | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | <1 |
| **alive, in poor physical conditions** | 0 | 0 | 41 | 0 | 0 | 0 | 3 | 0 | 44 | 6 |
| **injured** | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 7 | 1 |
| **dead, <1 week** | 19 | 0 | 176 | 3 | 0 | 3 | 1 | 0 | 202 | 28 |
| **dead, <1 week (without eyes)** | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | <1 |
| **dead, >1 week** | 15 | 1 | 318 | 0 | 1 | 2 | 1 | 3 | 341 | 48 |
| **dead indefinitely** | 2 | 0 | 95 | 1 | 0 | 0 | 0 | 13 | 111 | 16 |
| **unknown** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

In the assessment of the physical condition of the stranded birds (Table III), more than half of the cases (53%), the birds had such an advanced state of decomposition, that the determination of the status of the keel was not possible. A round and flat keel, that indicated a good and average physical condition, was only registered in 2% and 3% of the cases, respectively. For more than a quarter of the individuals (27%), the physical status remained undetermined.

Evidence for the cause of the stranding was in 81% unknown (Tab. IV). A poor physical condition was registered in 15% of the birds, in which 3% were considered malnourished. A dirty cloaca and evidence of paretic syndrome was recorded in 8% of the cases, mainly affecting gulls. Signs of predation were registered in 6% of the stranded birds, but 80% of these records reported that the predation was post-mortem. Only in 6 birds the predation was considered to be the main cause of the stranding, being reported predation by cats and birds of prey.

Around 1% of the individuals showed signs of bycatch in fishing gear, from which 1 Audouin's gull caught in a sport fishing hook, 5 Yellow-legged gulls, 1 Lesser Black-backed gull and 1 Northern gannet with evidences of capture by fishing nets, and 1 Yellow-legged gull with evidence of capture by longlines.

**Table III** | Number of stranded individuals per family by their physical condition, with total and %.

| Physical condition | Number of individuals per family | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Alcidae | Hydrobatidae | Laridae | Phalacrocoracidae | Procellariidae | Sulidae | Scolopacidae | Unknown | Total | % |
| **Round keel** | 2 | 0 | 10 | 1 | 0 | 0 | 0 | 0 | 13 | 2 |
| **Flat keel** | 0 | 0 | 19 | 1 | 0 | 0 | 0 | 0 | 20 | 3 |
| **Concave keel** | 7 | 0 | 99 | 0 | 0 | 2 | 2 | 0 | 110 | 15 |
| **Poor condition, does not allow the keel to be determined** | 18 | 0 | 347 | 2 | 0 | 3 | 3 | 4 | 377 | 53 |
| **Unknown** | 11 | 1 | 164 | 0 | 1 | 0 | 0 | 12 | 189 | 27 |

**Table IV** | Physical evidences, per bird family, detected during coastal inspections, with total and %

| Evidence of stranding | Number of individuals per family | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Alcidae | Hydrobatidae | Laridae | Phalacrocoracidae | Procellariidae | Sulidae | Scolopacidae | Unknown | Total | % |
| **Fisinhg gear** | 0 | 0 | 8 | 0 | 0 | 1 | 0 | 0 | 9 | 1 |
| **Stained with chemicals** | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | <1 |
| **Signs of predation** | 1 | 0 | 42 | 0 | 0 | 0 | 0 | 1 | 44 | 6 |
| **Dirty cloaca/Paretic syn-drome** | 3 | 0 | 53 | 1 | 0 | 1 | 0 | 0 | 58 | 8 |
| **Gunshot wounds (hunting)** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Malnourished/poor physical condition** | 10 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 18 | 3 |
| **Others** | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 4 | <1 |
| **Unknown** | 23 | 1 | 521 | 3 | 1 | 3 | 5 | 15 | 572 | 81 |

# 4 | Discussion

Gulls are among the most common stranded seabirds in Portugal, together with Northern gannets and alcids (Granadeiro *et al*., 1997; Carvalho *et al*., 2023; SPEA, 2023). As a resident species in Portugal, with an estimated 8,000 breeding pairs (Oliveira, *et al*., 2023), the Yellow-legged gull is frequently found stranded on beaches. Alongside this species, the Lesser Black-backed gull is also commonly stranded, as Portugal serves as both a crucial wintering ground and, to a lesser extent, a breeding site for this species (Meirinho, *et al*., 2014).

From March to September Barreta Island hosts significant colonies of Yellow-legged gulls (641 pairs) and Audouin's gulls (5394 pairs in 2022) (Pereira *et al*., 2022), along with approximately 50 breeding pairs of Lesser Black-backed gulls (T. Nascimento, personal communication). During this breeding period, it was registered the highest number of strandings for Yellow-legged gulls in spring (April to June) and for Audouin's gull in summer (July – September). The majority of stranded Yellow-legged gulls were adults, with the primary causes identified as poor physical condition and dirty cloaca, indicative of paretic syndrome. Data from the RIAS recovery center also showed that the main reasons of admittance of gulls were paretic syndrome and weakness (RIAS, 2024). These conditions may be exacerbated during the breeding season.

For Audouin's gulls the majority of strandings involved non-flying juveniles, which typically leave the colony area and gather near the beach. The high number of strandings during this period is likely linked to malnutrition or, as identified by RIAS, the prevalence of conditions like atherosclerosis and renal and joint gout of unknown origin (RIAS, 2024).

For Lesser Black-backed gulls, most strandings occurred during winter, coinciding with the peak abundance of this species in the country. These stranding events may be exacerbated by adverse weather conditions.

Additionally, coastal inspections recorded a significant increase in dead Alcidae (including Atlantic puffins and Razorbills) between the end of 2022 and early. This mass stranding event, observed on a larger scale along the coasts of Portugal and Spain, was primarily attributed to extreme weather (Oliveira *et al*., 2023). Mass strandings during migration can occur when birds face prolonged physical exertion (Trapletti-Lanti *et al*., 2024), leading to starvation, exhaustion, or drowning *(Morley, et al*., 2016), but can also be caused by entanglement in fishing nets (Costa, *et al*., 2019).

In this study, the majority of stranded seabirds, had an unknown cause of stranding, primarily due to the advanced state of decomposition in some cases, and the absence of visible external indicators of certain causes. However, direct evidence of bycatch was ruled out by observers in 98% of the strandings. It is possible that true impact of the fishing activities on seabird mortality is underestimated, as some cases there is only internal evidence that has to be accessed after necropsy. These necropsies often reveal signs of trauma, such as blood in the trachea, dark and hemorrhagic lungs, foaming, a stomach full of undigested fish, and internal bleeding (Simpson and Fisher, 2017; Costa *et al*. 2019). Despite these possibilities, the low incidence of observed bycatch in the region is supported by data from seabird admissions at RIAS (RIAS, 2024).

# 5 | Conclusion

The detection of stranded animals through coastal inspections is a tool for gathering data on the causes of seabirds strandings. Since seabirds are a good indicator of the state of the oceans, making this method useful for assessing the state of the marine ecosystem and identifying threats to its quality. The implementation of long-term monitoring programs helps to identify patterns related to causes of mortality, such as entanglement in fishing gear, oil spills, disease, or natural events like storms. Conducting systematic and regular transects builds a robust dataset that can be used in long-term studies, essential for understanding broader ecological shifts, such as changes in species distribution, abundance, or the effects of climate change on marine ecosystems.

However, several challenges complicate the accuracy of this method. Temporal and spatial biases, decomposition, scavenging, and the absence of visible injuries can obscure the true cause of strandings, making it difficult to assess the impacts. To address causes of death that are not immediately apparent, necropsies conducted by wildlife recovery centers can provide crucial insights into hidden injuries or conditions.

Additional limitations of the methodology include factors such as the observer's experience in accurately identifying species and determining causes of death, adverse weather conditions prior to inspections, coastal topography, the rate at which carcasses are removed by tides, and beach cleanliness. These variables must be considered when interpreting fluctuations in the number of stranded seabirds and other marine animals.

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