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Movement patterns of immature Yellow-legged Gulls *Larus michahellis* from Gran Canaria, Canary Islands

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Abstract

The Yellow-legged Gull subspecies *Larus michahellis atlantis* is thought to be resident in the Macaronesia islands, however, the movement patterns of the population remain largely unknown. We conducted a multi-year (2010–19) ringing and re-sighting programme on the island of Gran Canaria (GC), Canary Islands, with an aim of estimating the movement patterns of its gull populations. Re-sighting data revealed that most gulls were observed within 50 km of their natal sites; the farthest locality where studied gulls were seen was Dakhla (500 km from GC) in northwestern Africa. Our findings are compatible with the Yellow-legged Gulls adopting either a GC residency with some dispersal to other islands within the Canary Islands archipelago or to northern Africa, or a true partial migration strategy. Return to GC by some of the gulls that were observed outside GC suggests that philopatry to their natal site could be high, though this should be the focus of further investigation.

Introduction

The Yellow-legged Gull *Larus michahellis* is the most abundant of the large, white-headed gulls (genus *Larus*) from the southwestern Palaearctic and the Mediterranean basin (Olsen & Larson 2004), although its global population size is unknown (BirdLife International 2021). The Yellow-legged Gull population in Europe is estimated to have an increasing trend and be between 409,000 and 534,000 pairs (Staneva & Burfield 2017). According to several genetic, morphological, observational and phenological studies (e.g. Olsen & Larson 2004; Pons *et al*. 2004; Howell & Dunn 2007; Adriaens *et al*. 2020), the 'Macaronesian Yellow-legged Gull' comprises a subspecies *L. m. atlantis*. There is controversy about the range of *L. m. atlantis* because some authors consider this subspecies to only breed in the Azores (Dubois 2001; Yésou 2002; Olsen 2018), while others report that the subspecies breeds in the rest of the Macaronesian islands (Cramp & Simmons 1983; Olsen & Larson 2004; Howell & Dunn 2007), and even the northwestern African coast (Collinson *et al*. 2008). Recent preliminary genetic studies support the theory that the subspecies breeds throughout the Macaronesian islands and northwestern Africa (Arizaga 2018), but further studies are encouraged.

The Macaronesian Yellow-legged Gull population is considered to be resident (Cramp & Simmons 1983; Olsen & Larson 2004), though the movement patterns of these gulls remain largely unknown. A recent study using global positioning system (GPS) loggers showed that gulls from Madeira did not migrate and that they depended more on terrestrial than on marine habitats (Romero *et al*. 2019). Preliminary studies suggest low genetic flow among the main Macaronesian archipelagos (Canary Islands, Madeira, Azores), as well as between the archipelagos and the coast of northwestern Africa (Arizaga 2018).

In the Canary Islands archipelago, the population of Yellow-legged Gulls is estimated to comprise approximately 7,000 adult breeding pairs (Lorenzo 2007), although more recent reports suggest a population decline (Arcos *et al*. 2022). The species breeds throughout the Canary Islands archipelago, mostly concentrated in colonies (of variable size) along the coast of both the main islands and the smaller adjacent islets (Molina *et al*. 2022).

Previously, two short-term ringing projects have targeted Canary Island Yellow-legged Gulls. The first was a Darvic (PVC) ringing program in Tenerife, conducted in 2007. Here, one bird that was ringed as a chick was seen on the same island (its natal colony) the following year (D. Serrano, https://larusfuscus.blogspot.com/2010/07/anilla-canaria.html). The second project involved Darvic ringing by the Doñana Biological Station (anillamiento.ebd.csic.es), with c. 100 individuals ringed in Fuerteventura (1999–2000) and 14 in Lanzarote (2009).

Here, following a multi-year ringing programme carried out on the island of Gran Canaria (2010–19), we aim to estimate the dispersal and movement patterns of the Canary Islands Yellow-legged Gull population. This is the first study for the Canary Islands archipelago in which a Yellow-legged Gull population is surveyed long-term, and as far as we know, the only study where the movement patterns are investigated.

Methods

Study area and data collection

This study was carried out in the island of Gran Canaria (GC), where the most recently published census revealed a population of approximately 900 pairs of Yellow-legged Gulls (Martin & Lorenzo 2001). Most GC Yellow-legged Gull colonies are situated along the western coast of the island (Delgado *et al*. 1992), while other colonies/isolated pairs are found in the north and, to a lesser extent, along the eastern coast or within inland reservoirs (Delgado *et al*. 1992; Martin & Lorenzo 2001). Our ringing project was conducted at four colonies situated along the western coast of GC (Figure 1). These four colonies were condensed into three groups for the analyses: Agaete (ringing in this zone was carried out in two relatively close sites), Artenara (only two chicks, ringed in 2010) and Mogán (Figure 1). Gulls were ringed as chicks from 2010–17, mostly in May (although 25 out of 477 chicks were ringed in early June in 2010 and 2011), when they were 20 or more days old (Cantos 2000). Chicks were ringed with an official metal ring

Figure 1. The island of Gran Canaria within the Canary Islands archipelago with the four colonies where Yellow-legged Gulls *Larus michaehellis* were ringed as chicks depicted as stars. The dots indicate sites across the island where ringed Yellow-legged Gulls were re-sighted during 2010–19.

(Ministry of Environment of Spain) on the left leg (tarsus) and a Darvic (PVC) ring (yellow with a three-character black alpha-numeric code) on the right leg.

We compiled all the re-sighting data of the ringed gulls as soon as they fledged their respective colonies between 2010–19. Most observations of ringed gulls were made by the authorship team (73%). The remaining observations were reported by members via email, the ringing web platform from the Doñana Biological Station (www.ebd.csic.es), or the European colour-ring birding site (www.cr-birding.org).

Each observation comprised: the Darvic ring code, the observation date, the observation coordinates, and whether the bird was observed alive, sick, or dead. Although the ringing program ended in 2017, observation data were collected until the end of 2019 (an exceptional record of a bird in northwestern Africa obtained in 2020 was also included within our analyses). Overall, data were obtained over 222 days on GC, and over 28 days at locations elsewhere. Because Yellow-legged Gulls rarely venture inland on GC (X. Remírez, pers. obs.), the re-sighting efforts on GC were concentrated along the coast.

Data analyses

When ringed birds were re-sighted, we calculated their distance from their ringing site and the time elapsed between the date of ringing and the re-sighting. All analyses were done with R (R Core Team 2014).

Results

Overall, we ringed 477 chicks, the majority of which (475) were from two of the three study colonies (Table 1). Of these chicks, 154 individuals (32.28%) were seen alive at least once after they left their colony sites (Table 1) and 57 (12.0%) were seen at least once during the period of March to June one or more years after the year of ringing.

The percentage of individual gulls seen alive did not differ between the two high ringing effort colonies (χ^2 = 2.25, P = 0.134). In addition, we found five dead individuals (fully grown birds between 53 and 725 days after ringing) outside their natal colonies. Four birds had died from unknown causes, and one was found deceased on land next to a wind turbine. Due to the very low number of deceased gulls identified, hereafter we only consider the re-sighting data of living birds.

Table 1. Number of Yellow-legged Gulls *Larus michaehellis* ringed as chicks on Gran Canaria in addition to those seen following departure from their colony site. Total re-sightings data only refer to living birds only.

Colony	Individuals ringed	Individuals re-sighted	Total re-sightings
Agaete	223	Alive: 83; Dead: 0	228
Artenara	2	Alive: 0; Dead: 0	0
Mogán	252	Alive: 71; Dead: 4	158
Total	**477**	**160**	**386**

Table 2. Statistics regarding the sighting data obtained within and outside the island of Gran Canaria (GC), of Yellow-legged Gulls *Larus michahellis* ringed as chicks in GC during the period 2010–19.

	Sightings (of alive gulls)	Recoveries (of dead gulls)	Total individuals
Within GC	343	3	140
Outside GC	43	1	34

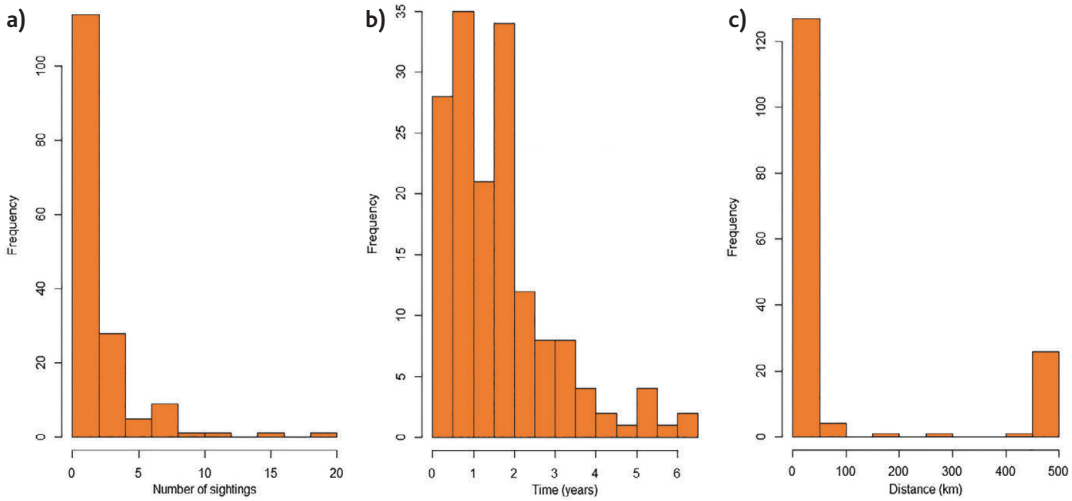
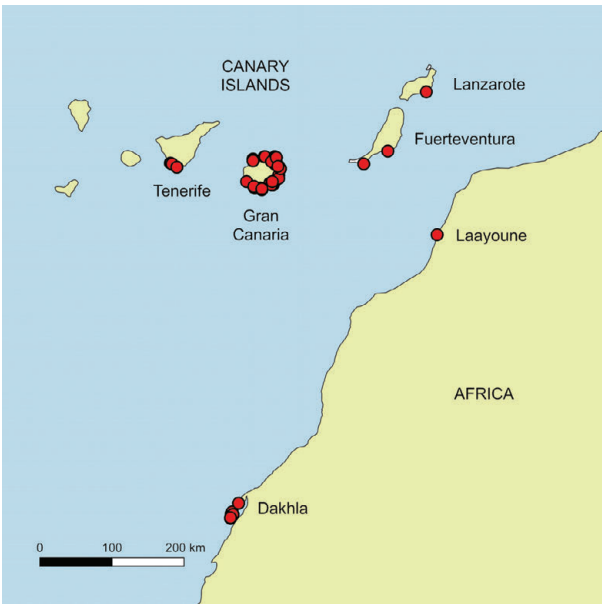


Figure 2. Metrics of Yellow-legged Gull *Larus michahellis* re-sightings; **a)** Number of occasions in which each individual was seen alive after fledging; **b)** Time elapsed between the ringing and the last sighting of those individual gulls that were seen alive after fledging from their colony sites; **c)** Maximum sighting distance of gulls seen alive after fledging from their colony sites.

Of the re-sighted gulls, 46% were observed only once (Figure 2a). The most frequently observed individual was seen on 20 occasions (Figure 2a). The mean number of days between ringing and final re-sighting was 600 days (standard deviation = 480 days; Figure 2b) and longest period after ringing at which a bird was observed was 2,206 days (or 6.04 years; Figure 2b).

Overall, of the 390 re-sightings, most were obtained within the island of GC (N = 346, 88.72%, Table 2). Indeed, most individuals were seen within 50 km of their natal sites (Figure 2c) and in GC, virtually all sightings were distributed along the coast (Figure 1). Re-sightings from GC comprised a relative homogeneous temporal distribution across the year.

Re-sightings of ringed gulls at locations outside GC were mainly in winter (40% in February, 76% from December to March; Appendix 1). Some GC-ringed gulls were re-sighted elsewhere within the Canary Islands archipelago, including Tenerife (N = 5), Fuerteventura (N = 2) and Lanzarote (N = 1; Figure 3). Other observations of ringed gulls were made along the coast of northwest Africa (Laayoune: N = 1), including up to 500 km from GC (Dakhla: N = 28; Figure 3). Only immature ringed Yellow-legged Gulls were seen in northwest Africa, their ages (from ringing date) ranging between 211 and 983 days (i.e. 0.6 to 2.6 years). Of the 34 gulls seen outside GC, 13 (38.2%) were seen both outside and within GC. Of the individuals observed both outside and within GC, the mean (± standard deviation) number of days between the ringing date and the re-sighting was 382 ± 208 days and 710 ± 497 days respectively (paired t-test: t = 2.266, P = 0.038; i.e. on average, those gulls seen outside GC were thereafter seen within GC). Distance observed from natal site tended to decrease as the age of the bird increased (Appendix 2).



Re-sightings of ringed birds at their breeding colonies were scarce, comprising only seven records at a single colony, Agaete (Table 3). Of these seven birds, four were seen before reaching sexual maturity, i.e. still showing immature plumage (Figure 4). The mean time interval between ringing date and the first re-sighting at Agaete was 3.00 years (range = 1.98–6.02 years), however, two birds were re-sighted more than once, and in these cases the last sighting was after six years (Table 3).

Figure 3. All the locations (red circles) where Yellow-legged Gulls *Larus michahellis* ringed as chicks on Gran Canaria were seen during the period 2010–19.

Table 3. Minimum time interval between ringing date and the date on which marked Yellow-legged Gulls *Larus michahellis* were seen within the colony of Agaete. (Gull A5W was seen again in 2014 and 2017 (giving rise to an interval of 6.04 years) and gull C2L was seen again in 2017 (giving rise to an interval of 5.05 years). Apart from being observed within the colony, there was no evidence of breeding in either bird.)

Ring code	Ringing date	Sighting date	Time difference (years)
A5W	14/05/2011	04/05/2013	1.98
A7W	22/05/2011	28/05/2017	6.02
C0R	04/06/2011	04/05/2013	1.92
C2F	12/05/2012	09/05/2015	2.99
C2L	12/05/2012	09/05/2015	2.99
F0A	18/05/2014	28/05/2017	3.03
F2P	16/05/2015	28/05/2017	2.04

Figure 4. Individual Yellow-legged Gull *Larus michahellis* with Darvic (PVC) ring C0R, seen in the Agaete colony 700 days (1.92 years) after being ringed as a chick. © *X. Remírez*. Note the presence of immature feathers in the wings.

Discussion

Here, we outline the dispersal patterns of Yellow-legged Gull fledglings from the Canary Islands. Ultimately, our re-sighting data indicated that most Macaronesian Yellow-legged Gulls remained close to their GC natal colonies. This suggests that this population is largely resident (Olsen & Larson 2004), with low juvenile/immature dispersal rates. These results, however, could be biased by the low sampling effort outside GC, both within the Canary Islands archipelago as well as along the coast of Africa. Indeed, the rate of gulls that were ringed as chicks and seen after they left their natal colonies (32%) was relatively small compared to other projects on the same species conducted elsewhere in Spain (e.g. 56% in Gipuzkoa, northern Spain; Arizaga *et al*. 2020). In part, our low re-sighting rate is likely attributable to a relatively small sampling effort due to a small community of birdwatchers within GC. Indeed, the number of days for which at least one ringed Yellow-legged Gull was observed in GC was 222 over a period of ten years (mean 22.2 days per year), and just 28 days for re-sightings obtained in other areas (e.g. outside GC).

Our data indicate that gulls from GC mainly reach the other islands of the Canary Islands archipelago, as well as the African coast, in winter (almost 80% of the sightings outside GC were obtained between December and March) when a substantial number of immature birds (N = 28) were detected. Gull movements away from GC could be indicative of dispersal whereby immature birds move to sites outside GC and are recruited to non-GC colonies. Preliminary work suggests a genetic exchange amongst the Yellow-legged Gull populations inhabiting the Canary Islands archipelago as well as between the Canary Islands archipelago and the coast of northern Africa (Arizaga 2018), so it is likely that some of the observed movements may represent a true, natal dispersal process. However, we currently lack evidence of GC Yellow-legged Gulls breeding in Africa whereas we did observe 13% of gulls that moved outside GC returning to GC.

The 'returning behavior' that we observed suggests that movements to other areas outside GC (e.g. to/along the coast of Africa) are perhaps rare, temporally variable and, seemingly, age dependent. A comparable movement pattern is observed in the Mediterranean Yellow-legged Gull *L. m. michahellis* population, for which the movement to the Bay of Biscay in winter mostly involves immature birds (Galarza *et al.* 2012). Gull movements outside GC could therefore be indicative of immature prospecting behavior or foraging dispersal, before ultimate recruitment to the GC breeding colonies. Indeed, during their immature period, gulls may take advantage of locally abundant food resources, even if resources are distant from GC. In this context, it must be noted that the deep, cold waters along the coast of northwest Africa generate a zone of high marine productivity which attracts immature Yellow-legged Gulls from the Canary Islands in addition to other seabird species that breed in the Canary Islands archipelago (Ramos *et al.* 2013). Similar juvenile movements, followed by a high proportion of birds returning to natal areas, have been observed within other gull species such as Lesser Black-backed Gulls *L. fuscus* in northwestern Europe (Olsen & Larsson 2004). Alternatively, we cannot reject the existence of a true partial migration strategy within the population, whereby some individuals exhibit a true migratory nature, at least in their immature stages, as suggested of some Mediterranean Yellow-legged Gull populations (Martínez-Abrain *et al.* 2002).

The relatively small re-sightings effort in the natal breeding and ringing colonies prevented us from drawing conclusions about recruitment rates. This being said, birds that were re-sighted at GC breeding colonies were observed within their natal colony. Furthermore, no birds that were ringed at colonies on GC were seen outside that colony as a breeder. Additionally, although we did not check whether adult ringed birds seen within their natal colonies were breeding, their recruitment as breeders is very likely. Apart from these adult birds, we also detected the presence of immature gulls within colonies during the breeding period. The observation of immatures within the colony may be associated with the prospecting processes (Dittmann *et al.* 2005). During prospecting, seabirds visit several sites in order to evaluate the quality and suitability of each colony for future breeding (Dittmann *et al.* 2005). Future work should include greater survey effort in the colonies to enable proper analyses of recruitment.

Although we did not survey colony size or breeding output in the current study, we noticed a decline in both the number of adults and chicks in the Agaete colony despite a similar sampling effort from year to year. This colony was located near two landfill sites which remained active at least the end of the 1990s and were closed around 2017–18 (Canary Government). Given that colonies have a strong link with nearby foraging resources (Egunez *et al*. 2017; Zorrozua *et al*. 2020), it is likely that the Agaete colony grew alongside the growth of the two landfills, only to subsequently decline once the landfill activity decreased and ultimately ceased.

In conclusion, the Yellow-legged Gulls from GC exhibit a movement pattern compatible with either a) a residential strategy with some dispersal (possibly foraging-related) to northern Africa, or b) a partial migration strategy. The return of ringed gulls to GC following observations outside GC suggests that philopatry to natal sites could be high; this should be the focus of future investigation. Furthermore, the implementation of two new Darvic ringing projects in the Azores and in the eastern islands of the Canary Islands archipelago will improve our knowledge on the movement patterns and population dynamics of the Macaroneasian Yellow-legged Gull populations. Efforts to encourage researchers to ring more chicks and increase the involvement of local people in reporting re-sighting data are imperative the success of future studies. The complementary use of GPS devices will be also crucial to close Yellow-legged Gull movement ecology knowledge gaps (Navarro *et al*. 2016; Romero *et al*. 2019).

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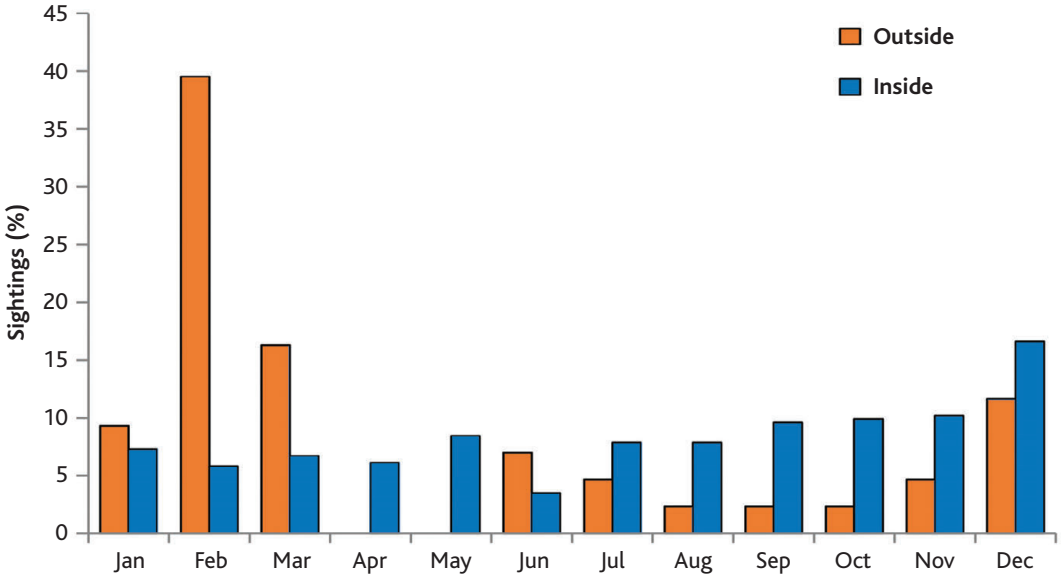
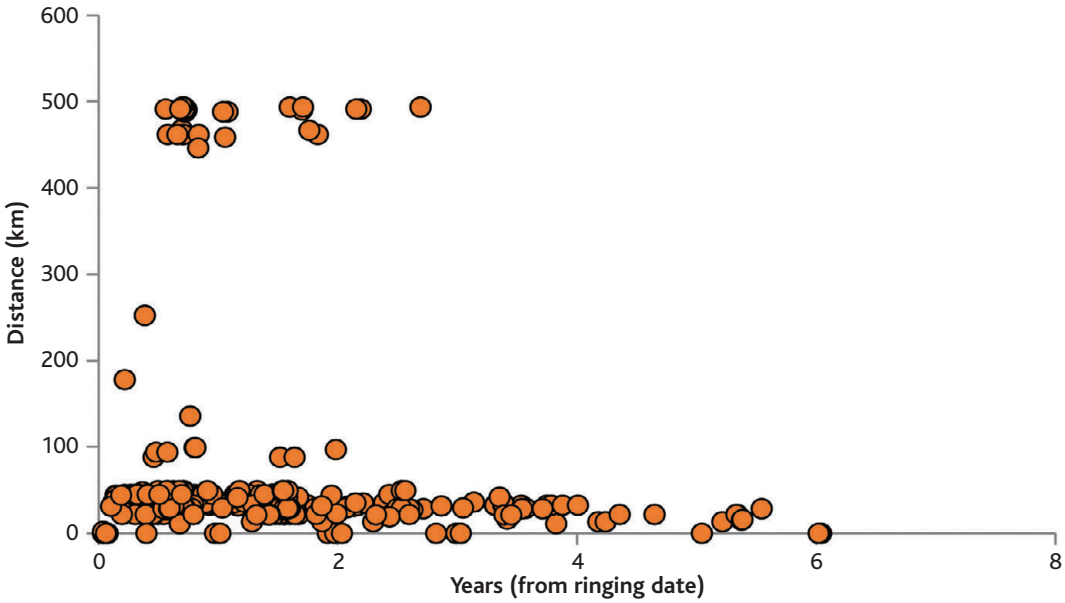


Appendix 1. Proportion of sighting records obtained outside and on the island of Gran Canaria (GC), relative to individual Yellow-legged Gulls *Larus michahellis* ringed as chicks in GC. In this figure, each individual bird has been considered only once per month.



Appendix 2. Relationship of the distance at which Yellow-legged Gulls *Larus michahellis* ringed as chicks in Gran Canaria were seen, according to their age since ringing.