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Aitor Galarza [a] , Alfredo Herrero [b] , Juan María Domínguez [c] , Asier Aldalur [b] & Juan Arizaga [b]

[a] Office of Conservation, Nature 2000 Network and Biodiversity, Biscay Regional Government, 48012, Bilbao, Spain

[b] Department of Ornithology, Aranzadi Sciences Society, 20014, San Sebastián, Spain

[c] Izate Environmental Partnership, 48901, Barakaldo, Spain

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Movements of Mediterranean Yellow-legged Gulls *Larus michahellis* to the Bay of Biscay

AITOR GALARZA[1]*, ALFREDO HERRERO[2], JUAN MARÍA DOMÍNGUEZ[3], ASIER ALDALUR[2] and JUAN ARIZAGA[2]

[1]*Office of Conservation, Nature 2000 Network and Biodiversity, Biscay Regional Government, 48012 Bilbao, Spain* [2]*Department of Ornithology, Aranzadi Sciences Society, 20014 San Sebastián, Spain* [3]*Izate Environmental Partnership, 48901, Barakaldo, Spain*

The movements of Mediterranean Yellow-legged Gulls *Larus michahellis michahellis* to the Bay of Biscay were analysed using sighting data of colour-ringed birds. A total of 1,270 sightings corresponding to 567 individuals was compiled over a 14-year period. Gulls originated mainly from colonies in the east of Iberia (52.7%), southern France (28.2%) and the Balearic Islands (17.3%). The proportion of the year spent in the Bay of Biscay decreased with age: first-year birds occurred on the coast of the Bay of Biscay throughout the year while older individuals were seen only from July to December. Overall, 39.7% of the birds were resighted in more than one calendar year. The return rate of adults and sub-adults was similar. The results confirm the importance of the Bay of Biscay as a non-breeding area (mainly in autumn and winter) for Yellow-legged Gulls from the Mediterranean, and suggest that this population should be considered as partially migratory.

The Yellow-legged Gull is currently split into three subspecies: *L. m. atlantis*, which is restricted to the Macaronesian islands, *L. m. michahellis*, which occupies mainly the Mediterranean seashores and *L. m. lusitanius* which breeds along the Atlantic coasts of the Iberian Peninsula (Olsen & Larsson 2004, Pons *et al* 2004). Preliminary studies carried out with the two last subspecies have shown that they exhibit different movement patterns: *michahellis* (Mediterranean Yellow-legged Gull) undertakes summer northward displacements to Atlantic coasts (Isenmann 1973, Carrera *et al* 1981, 1993, Yésou 1985, Le Mao & Yésou 1993, Martínez-Abraín *et al* 2002, Rodríguez & Muntaner 2004), whereas *lusitanius* (Cantabrican Yellow-legged Gull) appears to be resident (Munilla 1997, Pérez *et al* 2006, Arizaga *et al* 2009), with only a fraction of individuals performing movements of more than 50 km from their natal areas (Arizaga *et al* 2010).

Preliminary studies have already underlined the importance of the Bay of Biscay as a foraging area for the Mediterranean Yellow-legged Gull (Yésou 1985, Le Mao & Yésou 1993, Munilla 1997). However, detailed analyses of their movement patterns in this area (*eg* throughout the year and between age classes) are scarce and have been made with small sample sizes and lumped age classes, or focused on birds which originated from only a few colonies (Munilla 1997, Álvarez Laó 2001, Martínez-Abraín *et al* 2002, Rodríguez & Muntaner 2004). The generalised use of Darvic rings has greatly improved the reporting rate for ringed gulls (Shedden *et al* 1985, Rock 1999). The use of such rings, together with the expansion of ringing projects and an increasing network of birdwatchers, has allowed more detailed analyses of the movements of large gulls in Europe (Arizaga *et al* 2010). These analyses of movement patterns of species that usually live in close association with humans must be regarded as fundamental when elaborating conservation policies, planning population control or assessing potential health risks for humans.

Our aim in the present study was to analyse the movements of Yellow-legged Gulls from the Western Mediterranean colonies to the Bay of Biscay. More specifically, we studied whether such patterns differed throughout the year and with age. Some authors have reported that adult Mediterranean Yellow-legged Gulls tend to be resident or to visit non-breeding areas for shorter periods than sub-adults (Carrera *et al* 1981, Martínez-Abraín *et al* 2002). In this scenario, we expected a higher proportion of sub-adults than adults in the Bay of Biscay throughout the annual cycle. If adults dominate over sub-adults and these are forced to exploit suboptimal resources, adults would be expected to be proportionally more abundant at sites offering optimal feeding conditions, such as refuse tips. It has been hypothesised that the movement patterns of Mediterranean Yellow-legged Gulls depend on the type

* Correspondence author
Email: agalarza@telefonica.net

of food they exploit in their breeding areas (Le Mao & Yesou 1993). Gulls from colonies that depend more on stable food sources, such as refuse tips, are likely to be less migratory than gulls exploiting seasonal food sources, such as marine prey. If this hypothesis is correct then gulls from colonies close to stable food sources will be less abundant in a non-breeding zone like the Bay of Biscay than gulls from colonies more dependent on seasonal food sources.

METHODS

Sampling area and data collection

We used sighting data of Darvic-ringed Yellow-legged Gulls marked as chicks in breeding colonies from the Western Mediterranean between 1996 and 2010, which were later recorded in the southern Bay of Biscay. The sighting area in the Bay of Biscay included the shoreline and coastal refuse tips between Northern Aquitaine (France) (43°31'N 1°15'W) and western Asturias (Spain) (43°33'N 7°01'W) (Fig 1).

We compiled 1,270 records corresponding to 567 Mediterranean Yellow-legged Gulls observed in the study area from July 1997 to June 2011. We also used 215 sightings, collected in the Mediterranean, of individuals previously observed in the Bay of Biscay. Only one sighting per month in each year was used for each individual. The origins and ages of the ringed gulls were determined from the ringing details reported by the corresponding ringing schemes. We adopted six age classes: 1st-year, 2nd-year, 3rd-year, 4th-year, 5th-year and adult. Sightings after 1 July were considered to belong to the next year-age class.

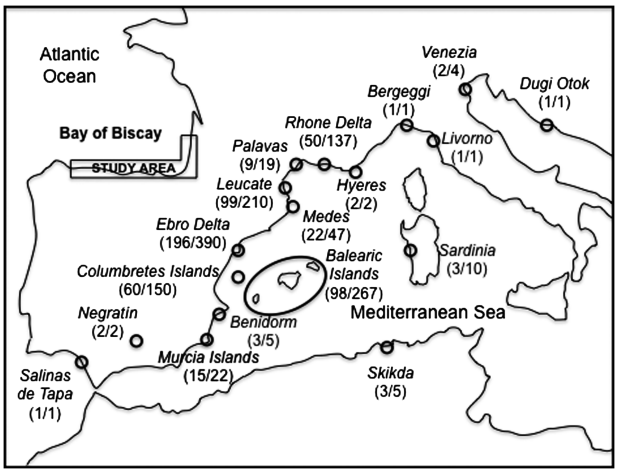

Figure 1. Study area and geographic location of colonies of Mediterranean Yellow-legged Gulls sighted in the southern Bay of Biscay (number of sighted individuals/total number of sightings).

Data analyses

We used contingency tables and chi-square tests to compare frequencies of sightings between groups. First, we asked whether the proportion of each age class differed through the year, to check if there was a different seasonal use of the area in relation to age. To avoid zero values, data were grouped into four-month periods: July–October, November–February and March–June. Second, we checked whether the frequencies of individuals resighted in the Bay of Biscay were independent of age, thus allowing us to determine whether or not the return rate to the Bay of Biscay of Mediterranean individuals decreased with age. Third, we tested whether the proportions of sightings of each age class at refuse tips were different from those along the coast. This test allowed us to check whether there was a differential use of feeding sources in relation to age. Finally, we tested whether movement patterns were associated with feeding resources at breeding colonies, by using the proportions of sighting data of individuals from two Mediterranean areas where gulls depend on very different feeding resources: the Columbretes Islands, where gulls depend on marine fish, and the Murcia Islands, where gulls feed mainly on refuse tips (Ramos *et al* 2009). To reduce the bias associated with sampling effort (both when sighting and ringing) we used only data on birds ringed in 2005, 2009 and 2010 from these two areas: during these years ringing programmes were developed in both areas and ringing effort data were available. Analyses were performed with the SPSS v19.0 statistical package.

RESULTS

The Mediterranean Yellow-legged Gulls moving to the Bay of Biscay originated from 18 ringing localities situated mainly along the coast of Iberia from Andalusia to Catalonia (52.7%), southern France (28.2%), and the Balearic Islands (17.3%) (Fig 1). One exceptional record related to a bird in its third calendar year, which had been ringed as a chick 1,630 km away in Croatia.

The proportion of each age class in the Bay of Biscay differed through the year ($\chi^2_{10} = 103.29$, $P < 0.001$), demonstrating a decrease in annual residency with age. Thus, 1st- and 2nd-year gulls stayed in the study area for the whole annual cycle, whereas most 5th-year individuals and all adults were observed from July to December (Fig 2).

First-year individuals were first sighted in the Bay of Biscay 52.3 ± 12.3 (mean ± SD) days after being ringed (n = 41 individuals sighted in July). The earliest record corresponded to a bird observed 37 days after being ringed in the Balearic Islands. Early 1st-year Mediterranean Yellow-legged Gulls were observed in the Bay of Biscay on 9 July, although most records were collected from mid July onwards, with the bulk from August to October, and decreases from November onwards (Fig 2). Some 2nd-year gulls remained in the Bay of Biscay, whilst others were resighted on the Mediterranean coasts from October to June (Figs 2 & 3), thus reflecting a dual strategy for the same population. Some sub-adults remained in their wintering areas for the whole year, whilst others returned to their natal areas.

Of 534 ringed birds observed (birds ringed in 2010 being excluded), 212 (39.7 %) were resighted in the Bay of Biscay in more than one calendar year. The record for wintering site fidelity related to two individuals from the Rhône Delta observed in the same area of the Bay of Biscay for eight consecutive seasons. The proportions of resighted individuals did not vary between age classes ($\chi^2_5 = 9.58$, $P = 0.088$).

Foraging at refuse tips was observed for 27.3% of the individuals (14.5% of the sighting data). Sightings at refuse tips were age related, being significantly lower than expected in 1st-year individuals and higher in adults ($\chi^2_5 = 34.97$, $P < 0.001$; Fig 4). We found significant differences ($\chi^2 = 16.19$, $P < 0.001$) when we compared the observed frequencies of gulls sighted in the Bay of Biscay which had originated from the Columbretes Islands (18 observed from 228 ringed) with those from the Murcia Islands (three observed from 301 ringed).

DISCUSSION

Previous studies suggested that sub-adult Yellow-legged Gulls from several western Mediterranean colonies left their natal areas and moved erratically before reaching, among other zones, the Bay of Biscay, whereas adults remained near their breeding sites throughout the year (Isenmann 1973, Carrera *et al* 1981). However, more recent studies postulated that these movements were not erratic and involved both sub-adults and adults, and thus might represent a true migration (Yésou 1985, Carrera *et al* 1993). Our results confirm now that many Mediterranean Yellow-legged Gulls of all age classes return to the Bay of Biscay year after year and thus exhibit one of the main characteristics of avian migration. Moreover, the tendency to return to the Bay of Biscay did not decrease with age, also supporting the view that these movements are not merely dispersive but

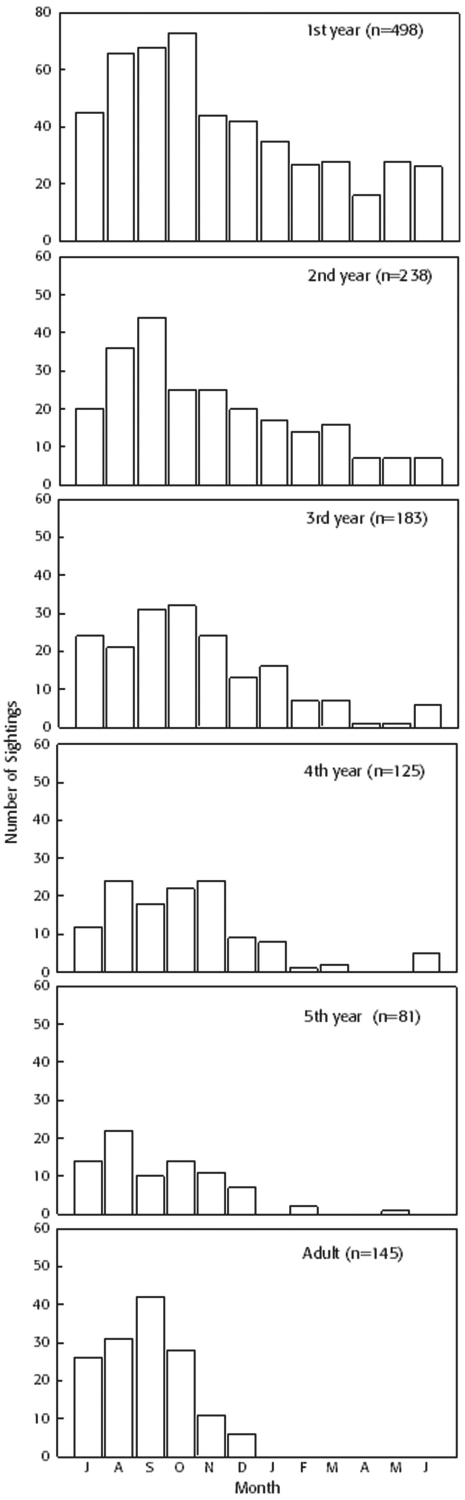

Figure 2. Number of sightings of Mediterranean Yellow-legged Gulls in the southern Bay of Biscay by age class and month.

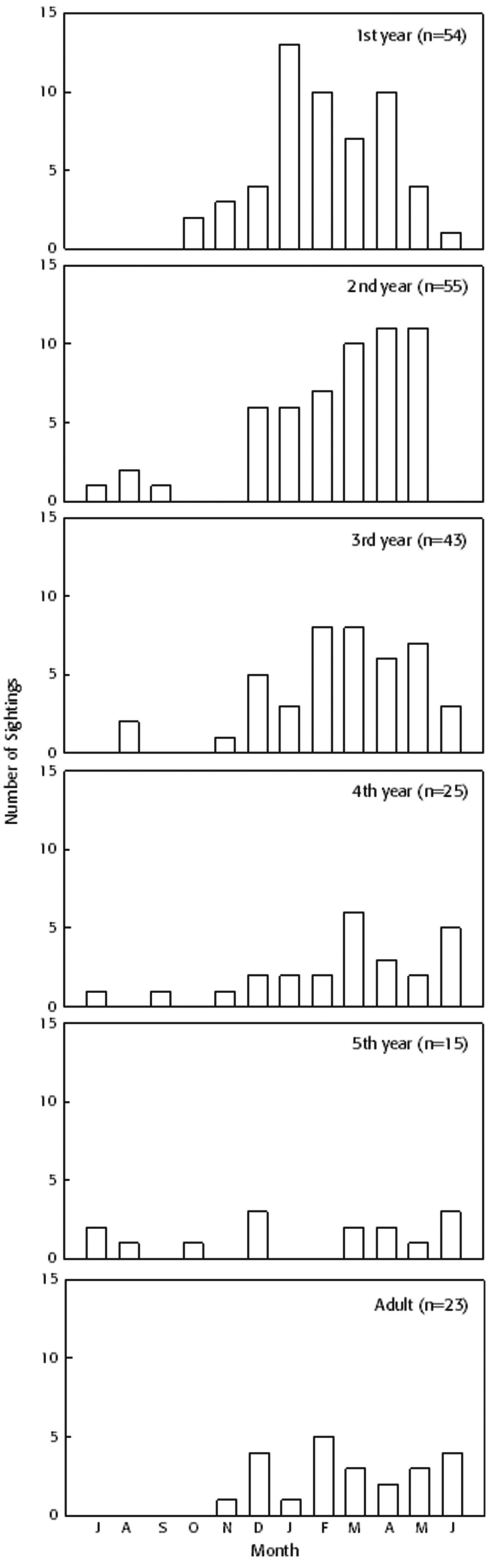

Figure 3. Number of sightings in the Mediterranean of Mediterranean Yellow-legged Gulls previously sighted in the southern Bay of Biscay, by age class and month.

migratory. Therefore, we suggest that Mediterranean Yellow-legged Gull should be considered as an obligate partial migrant, as defined by Terrill & Able (1988).

The ultimate factor promoting bird migration is the seasonal availability of food as a consequence of changing environmental conditions (Berthold 1993). Marine productivity decreases sharply in the Mediterranean from May to November (Margalef 1984) and intertidal food is scarce due to the narrow variation of sea level. Moreover, competition for food increases greatly when fledglings leave the colonies and become independent. Thus, Mediterranean Yellow-legged Gulls must find alternative food resources or move to other areas with more available food. In contrast to the Mediterranean, the Bay of Biscay contains spawning areas, fisheries and extensive intertidal areas (Le Mao & Yésou 1993, Borja & Collins 2004), being a rather more stable and richer environment that is also exploited by an increasing resident Yellow-legged Gull population (Arizaga *et al* 2009).

Le Mao & Yésou (1993) suggested that those individuals that are less opportunistic or that forage mainly in variable sources might leave the Mediterranean, since they would be unable to adapt efficiently to the changing food supply. In contrast, those strongly dependent on stable food sources, such as refuse tips, would remain closer to the breeding areas. If so, the currently increasing abundance of alternative food originating from human activities in the Mediterranean (Duhem *et al* 2003, Ramos *et al* 2009) could lead to an increase in survival of non-migratory individuals, together with a reduction in the migratory trend of those colonies dependent on more reliable and predictable food sources, such as refuse tips. On the Bay of Biscay we observed that gulls from an area reported to be highly dependent on refuse tips were less abundant than those gulls from an area reported to depend on a more variable food source, such as fish discards, thus supporting the hypothesis that the migratory trend of Mediterranean Yellow-legged Gull is related to their foraging behaviour during the breeding season (Le Mao & Yésou 1993).

Sightings at refuse tips involved birds of all age classes, although adults used them more frequently than 1st-year individuals, possibly because of learned experience of the most favourable feeding areas. Moreover, 1st-year gulls are considered inferior in foraging efficiency (Burger & Gochfeld 1981), so dominance interactions between individuals may also play an important role in this resource utilisation. Arrival dates suggested that many gulls from the Mediterranean coasts left their colonies on becoming independent. Because Mediterranean Yellow-legged Gulls lay on average a month earlier than their Atlantic counterparts (Pons

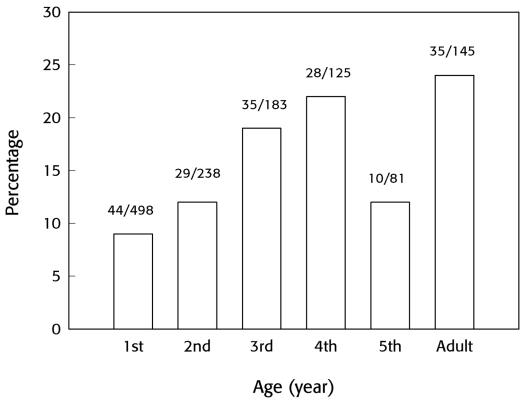

Figure 4. Percentage of sightings of Mediterranean Yellow-legged Gulls at refuse tips of the Bay of Biscay in relation to the total number of sightings in the area, by age class (number of sightings at refuse tips/total number of sightings).

et al 2004), individuals from the Mediterranean colonies arrived in the Bay of Biscay when local fledglings and adults were still in their colonies. Therefore, young Mediterranean individuals might take some advantage of this different breeding phenology, for example by exploring earlier, which might possibly lead to better survival. The two youngest age-classes stayed longer in the Bay of Biscay, thus avoiding the social dominance and competition for food near the Mediterranean colonies. In contrast, the year-round presence of older juveniles in the study area reduced with age, probably because prospecting suitable areas for later breeding would be increasingly important for older birds, as has been suggested in other migratory gulls (Kilpi 1984, Marques *et al* 2010).

In conclusion, our results support the hypothesis that the Mediterranean Yellow-legged Gull population is partially migratory, and also the view that this subspecies is genetically adapted to the seasonality of the Mediterranean productivity through part of its population remaining migratory, in order to avoid the depletion of natural food resources which occurs during the summer.

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