



## The origin of Lesser Black-backed Gulls *Larus fuscus* wintering in central Iberia

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The origin and age of Lesser Black-backed Gulls *Larus fuscus* wintering inland on the Iberian Peninsula were mapped using sightings of colour-ringed birds. A total of 288 individuals were sighted over a 17 year period. The gulls originated from seven different countries, with the majority being ringed in the United Kingdom and the Netherlands. The most commonly resighted age group were adults, and most birds were sighted two years after ringing. Our analysis provides evidence for a change in the migration patterns of Lesser Black-backed Gulls, which may be explained by Baker's exploratory migration model. It is probable that the gulls follow the rivers Tagus and Guadiana to the rubbish tips in the inner part of the Iberian Peninsula. The prevalence of adult birds could indicate that Lesser Black-backed Gull has become established as a regular wintering species in the inner part of the Iberian Peninsula.

In spite of the existence of several models to explain migration patterns in vertebrates, the exploratory migration model (Baker 1978a, b) is the one most applied to birds. This model suggests that young vertebrates acquire knowledge of an area far larger than needed as adults. Juvenile dispersion is followed by an exploration phase by immatures and the migration patterns of adults are based upon the knowledge they acquire during their exploration (Baker 1980). The exploratory model implies that birds have the ability to rapidly change their migration patterns in response to changes in the environment. If the immature birds find unused, but suitable, wintering areas during the exploration phase, the effect might be that they return to the same areas in subsequent years and partly change the migration pattern of the population. The model also predicts that the exploratory phase must be more common among immatures than adults, whereas adults should predominate in established wintering areas.

According to Baker (1980) the Lesser Black-backed Gull *Larus fuscus* is a species that apparently fits into the exploratory model. Other migration models, such as the clock and compass model (Perdeck 1958) and the goal-area navigation model (Rabøl 1970, 1978), do not explain the changes in migration patterns observed in the Lesser Black-backed Gull (Baker 1980).

Baker (1980) analysed the migration patterns of Lesser Black-backed Gulls ringed in Britain & Ireland using the

recoveries of ringed birds. He suggested that the principal factors influencing changes in migration patterns of Lesser Black-backed Gulls may have been climatic changes and the increased tendency of the birds to forage at human rubbish tips, although the increase in the population over the second half of the twentieth century (Barnes 1953, 1961, Sharrock 1976) could also have had an effect. Hence, rubbish tips may act as detection points for Lesser Black-backed Gulls in the exploration stage. Moreover, Sol & Lefebvre (2000) have shown that the invasion success of the species is partly related to the rapid adoption of new food resources, and their pair-wise comparisons of closely related species indicate that successful invaders show a higher frequency of foraging innovations in their region of origin. Thus, the role of the rubbish tips in the change of the migration patterns of the species seems compelling.

In the Iberian Peninsula the number of wintering Lesser Black-backed Gulls has increased along the coast (Díaz et al 1996) and inland, where they forage at large rubbish tips (Nelson 1980, Gómez & de Juana 1984, Gómez-Tejedor & de Lope 1993). However, the rubbish tips are only exploited when adverse environmental conditions reduce the abundance of natural food resources (Greig et al 1986, Galván 2000). The movement inland is facilitated by artificial dams and large rivers where birds may concentrate in winter (Bermejo et al 1986, Sánchez et al 1991, Traverso 1999, 2000).

Several gull species exploit rubbish tips (Monaghan 1980,

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Götmark 1984, Greig et al 1986, Noordhuis & Spaans 1992, Gómez-Tejedor & de Lope 1993, Sol et al 1993), but it is unknown to what extent the Lesser Black-backed Gulls wintering in the Iberian Peninsula use these areas. Lesser Black-backed Gulls are, however, most numerous in regions such as Madrid and Extremadura where large rubbish tips are available to the birds (Díaz et al 1996).

In this study we have mapped the origin and age of the Lesser Black-backed Gulls wintering in the Iberian Peninsula using sightings of colour-ringed birds ringed during the breeding season in other countries. We also discuss probable migration routes and possible causes for the population increase observed in the inland of the Iberian Peninsula.

## METHODS

The study was carried out during 1984-2001 at the rubbish tips at Badajoz (38° 53'N, 06° 58'W), Villanueva de la Serena (38° 58'N, 05° 48'W) and Pinto (40° 15'N, 03° 42'W) (Fig 1). Badajoz and Villanueva de la Serena are located in the west (Extremadura) and Pinto (Madrid) in the middle of Spain. In addition, we included material from other localities in Spain (Fig 1) and sightings provided by ringers in other countries, including the countries in which the gulls were ringed (Table 1).

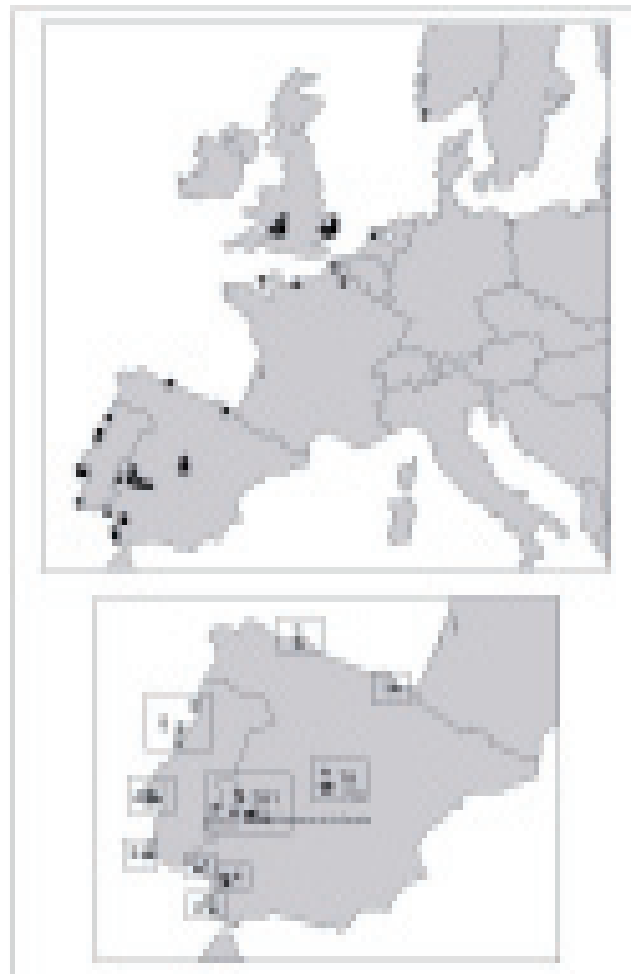
The handling of the sightings was carried out using a specially designed data base [CLIPPER (Computer Associates)] developed by VB. This programme enabled us effectively to search and sort the ringing and sighting data.

Similar to Barnes (1961) and Baker (1980), we assigned the birds into four age classes. Adult birds were defined as four years or older, while immature birds were categorised as first, second and third winter. The winter period was defined as 1 October to the end of February. The data presented from Spain were obtained from November until February as most birds are present in this period (Gómez-Tejedor & de Lope 1993). The term "sighting" refers to a sight record of a colour-ringed bird.

We used non-parametric statistics as the data were not normally distributed (Sokal & Rohlf 1995). We used G tests to compare frequencies of sightings between groups. The Kruskal-Wallis test was used to compare the medians of the numbers of sightings throughout the study period (Zar 1999). Means are expressed with 95% confidence limits.

## RESULTS

The distribution of sightings of colour-ringed Lesser Black-backed Gulls found in Iberia is shown in Fig 1. The ringing



**Figure 1.** Geographical distribution of the sighting localities of colour-ringed Lesser Black-backed Gulls. The lower map shows the principal areas in the Iberian Peninsula and the number of sightings.

**Table 1.** Countries of ringing and sighting of Lesser Black-backed Gulls included in this analysis. Sightings within the country of ringing are included.

|                 | Country of ringing |      | Country of sighting |            |      |
|-----------------|--------------------|------|---------------------|------------|------|
|                 | Number             | %    | Individuals         | Sightings  | %    |
| Belgium         | 1                  | 0.2  | -                   | -          | -    |
| France          | -                  | -    | 3                   | 5          | 1.1  |
| Germany         | 1                  | 0.2  | -                   | -          | -    |
| Iceland         | 1                  | 0.2  | -                   | -          | -    |
| Ireland         | 1                  | 0.2  | -                   | -          | -    |
| The Netherlands | 128                | 39.7 | 1                   | 17         | 3.7  |
| Norway          | 2                  | 0.7  | 1                   | 1          | 0.2  |
| Portugal        | -                  | -    | 11                  | 12         | 2.6  |
| Spain           | -                  | -    | 279                 | 369        | 80   |
| United Kingdom  | 154                | 58.8 | 30                  | 57         | 12.3 |
| <b>Total</b>    | <b>288</b>         |      | <b>325</b>          | <b>461</b> |      |

sites are shown in Fig 2. Of 288 ringed birds, 75 (26%) were sighted more than once (mean number  $3.3 \pm 0.2$ ). The gulls originated from 30 different ringing localities in seven European countries (Table 1). Most were ringed in the United Kingdom and the Netherlands. A total of 280 (97.2%) individuals were ringed as chicks, one in the first year, two in the third year and five older than three years.

Of the colour-ringed birds which were resighted following ringing, adults outnumbered immatures overall ( $G = 43.54$ ,  $df = 3$ ,  $P < 0.001$ ) and within the Iberian Peninsula ( $G = 23.07$ ,  $df = 3$ ,  $P < 0.001$ ). This predominance of adults was more dominant in the rest of Europe ( $G = 34.94$ ,  $df = 3$ ,  $P$

$< 0.001$ ), closer to the breeding colonies. The distribution of the sightings in Spain in winter showed that most of the sightings were obtained in December ( $G = 132.91$ ,  $df = 3$ ,  $P < 0.0001$ , Fig 3). There were no significant differences in the annual distribution of sightings during the last 10 years of the study period ( $H = 13.05$ ,  $df = 9$ ,  $P > 0.1$ , Fig 4).

In Spain we found no differences in the proportions of age classes within each month ( $G = 11.16$ ,  $df = 9$ ,  $P > 0.25$ , Fig 3). An exact age of the birds was determined for 95.7% of the sightings; birds of two years of age were the most abundant age group ( $G = 407.10$ ,  $df = 14$ ;  $P < 0.0001$ , Fig 5).

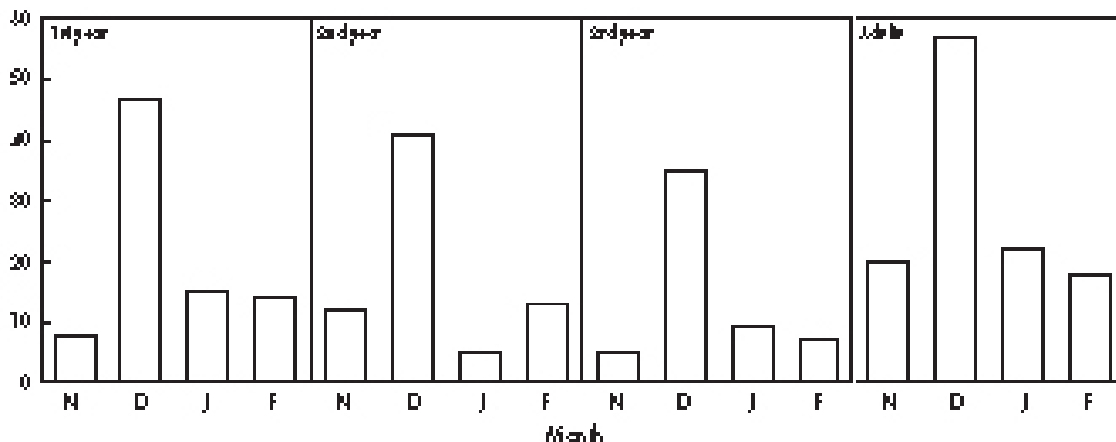


**Figure 2.** Geographical distribution of the ringing localities of colour-ringed Lesser Black-backed Gulls sighted during this study.

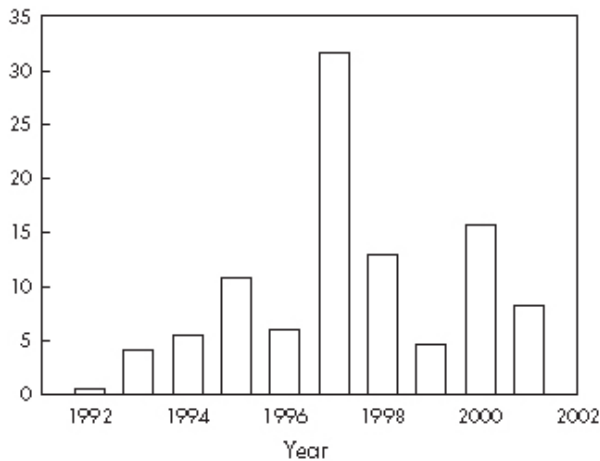
**DISCUSSION**

We consider the material representative for the Iberian Peninsula because of the wide geographical distribution of the localities included and the lack of Lesser Black-backed Gull observations from other inland localities. In Spain, colour-ringed Lesser Black-backed Gulls have been looked for in many locations, and have been reported to one of the authors (JM).

Baker (1980) found that the migration patterns of Lesser Black-backed Gulls from Walney Island in Great Britain had changed during the period 1962-1975. At the end of this period, the adults and immatures spent more time further north than previously. However, the pattern of independent exploration by immatures during the 18 months from November of their first year did not change during the period. The same applied to the winter exploration of more northern areas by second-year birds and the southward retreat that follows in March and early April. However, the northward migration back to the breeding grounds by second-year birds seemed to occur



**Figure 3.** Winter sightings of colour-ringed Lesser Black-backed Gulls in Spain by age class.



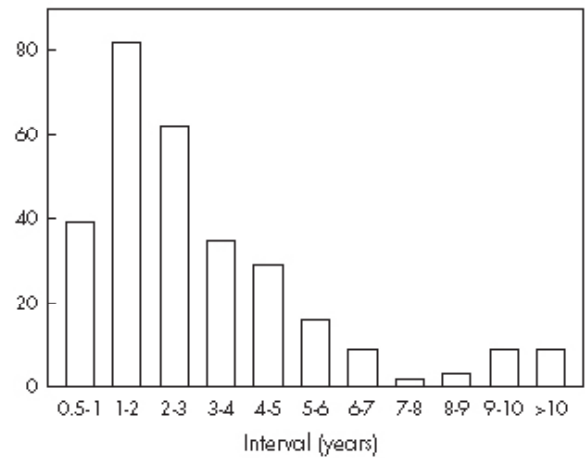
**Figure 4.** Annual percentage of the total number of sightings of colour-ringed Lesser Black-backed Gulls, 1992-2001.

earlier towards the end of the period. In 1969-1975, 10% of the adults spent the entire winter in Iberia, occasionally some birds did brief sorties inland to Spain and North-Africa (Baker 1980).

Matthews (1952) and Barnes (1961) have shown that the majority of Lesser Black-backed Gulls wintering in Great Britain were adult birds. Hence, one could expect that immatures would be the commoner age class in the Iberian Peninsula. Our results show a predominance of adult birds, as also has been demonstrated in other studies (Galván 2000). This adult predominance may be a result of young birds finding suitable wintering areas during the exploratory phase and returned to the same areas as adults. Baker (1980) mentioned climatic change, an increased inclination to feed on rubbish tips and a large increase in the Lesser Black-backed Gull population as possible causes of the observed change in the migration pattern. Use of rubbish tips could also explain the increase of the winter population of Lesser Black-backed Gulls in inland areas of the Iberian Peninsula.

The larger proportion of adults found outside the Iberian Peninsula and closer to the breeding colonies suggests that immatures move further away from the breeding areas. This tendency has also been reported by Kilpi & Saurola (1984), as well as for other gull species (Belant & Dolbeer 1993, Barrett & Bakken 1997, Munilla 1997, Martínez-Abrain et al 2002). Kilpi & Saurola (1984) suggested that second-summer Lesser Black-backed Gulls are rare in Finland because most of the immatures spend the summer within the wintering areas. Hence, the predominance of two year-old birds in Iberia.

It seems that the gulls select a migration route from North Europe along the coasts of the British Isles and Central Europe. They arrive at the Iberian Peninsula from the western coast of France (Baker 1980, this study). On



**Figure 5.** Number of sightings of colour-ringed Lesser Black-backed Gulls in relation to time between ringing and sighting.

a basis of the geographical position of the recoveries in inland Spain we propose that the basins of the Iberian rivers, probably Tagus and Guadiana, are used by the gulls to travel inland (Fig 6). A large number of Lesser Black-backed Gulls spend the winter in the Tagus estuary (Díaz et al 1996). These river systems may provide areas for communal roosting, which reduce the physiological cost associated with thermoregulation and the risk of predation, thereby increasing the efficiency of food search (Beauchamp 1999). Large rubbish tips located along these rivers systems are also attractive to the gulls. By entering the inland regions by the river systems the gulls are able to avoid flying over the mountains of northern Spain (Tellería et al 2001).

Kilpi & Saurola (1984) showed that the race *L f fuscus*, which breeds in Scandinavia, used a different migration route across Europe than the other subspecies, *L f graellsii* and *L f intermedius*, in western Europe. The *fuscus* subspecies also spent the winter in different areas and probably did not mix with the two other subspecies. The lack of sightings in the study area of birds ringed within the breeding range of the *fuscus* race support the claim for two different migration routes in Europe; an eastern route followed by the *fuscus* race around the eastern Mediterranean before entering Africa (Kilpi & Saurola 1984), and a western route followed by the other two races with a fraction of birds coming into the Iberian Peninsula.

If the immature birds migrate longer distances to explore new areas than the adults, we could predict a low proportion of adults in the study area. However, a higher proportion of adults than immatures was recorded (Galván 2000, this study). This predominance of adults in the study area could indicate that young birds found suitable wintering areas and later returned to these areas as adults.



**Figure 6.** Proposed routes followed by Lesser Black-backed Gulls across Europe to inland Iberia.

By considering the topography of the inland regions of the Iberian Peninsula we propose that the Lesser Black-backed Gull has reached the maximum distribution in this area. The lack of other large rivers leading into Spain is probably the main limitation to further spread of the species inland.

Although it is difficult to verify which of the three factors proposed by Baker (1980) is most important in explaining the change in the migration of Lesser Black-backed Gulls, Kilpi & Saurola (1984) pointed out that the rigidity of the traditional migration routes has been increased by the fact that the subspecies *L. f. fuscus* was unable to utilise new food resources, such as dumps. Recent studies show that the forms *fuscus* and *graelsii* are not entirely different gulls (Crochet et al 2002), and so it seems clear that the behaviour of the Lesser Black-backed Gull has changed, which allowed for the establishment of new wintering areas (Baker 1980, Kilpi & Saurola 1984). In the inland regions of the Iberian Peninsula, it is possible that the proliferation of large rubbish tips during the last two decades (Gómez & de Juana 1984, Cantos & Asensio 1990, Gómez-Tejedor & de Lope 1993) is the main factor for the change in the wintering areas. Climate warming has affected the distribution and abundance of bird species in Europe (Hughes 2000), and the climatic fluctuations in the Mediterranean region might have significant impacts on migrants crossing the European continent (Sanz 2002). Gaston & Blackburn (2002) have suggested that dispersal distance might increase with colonization rate if there

were some directional shift in the positions of the ranges of species, such that some areas were becoming available for fresh colonization, perhaps as a product of climate change. However, we can not assess the importance of this factor in relation to the change in the migration patterns and wintering areas of the Lesser Black-backed Gull. A possible future reduction in the number and accessibility of rubbish tips (Garrido & Sarasa 1999, Carranza 2001) combined with monitoring of the winter population of Lesser-black Backed Gull in inland Iberia, could probably show if climatic change is the main factor affecting the selection of wintering areas.

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