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ORIGINAL PAPER

# Foraging distances of a resident yellow-legged gull (*Larus michahellis*) population in relation to refuse management on a local scale

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**Abstract** Seasonal fluctuations in marine prey availability around breeding colonies are one of the major factors affecting resident behaviour in seabirds. This is particularly applicable to large gulls (*Larus* spp.). The effect of refuse management on large gulls has been studied chiefly in relation to breeding dynamics, but it is less understood with regard to movement patterns. Our aim was to test whether the closure of one large dump and the use of falconry to deter gull access to two others, within the southeastern Bay of Biscay area, affected the foraging distance of local yellow-legged gulls (*Larus michahellis*). During a period of seven consecutive winters between 2005 and 2011, the proportion of gulls that moved less than 50 km from their natal site was 70 %. However, during the winter of 2010, when they were deterred from accessing refuse tips within the region, gulls were found to travel longer distances. This result was explained neither by a decreasing survey effort near colonies nor by a decrease in apparent availability of marine prey, thus supporting the hypothesis that refuse management within the region influenced the movement patterns of local gulls.

**Keywords** Bay of Biscay · Colony breeding seabirds · Dump · Foraging tactic · Monte Carlo simulations · Refuse tips

## Introduction

Human activity often produces a superabundance of food that is used opportunistically by generalist foragers (Lunn and Stirling 1985; Blanco and Marchamalo 1999; Tortosa et al. 2002; Ramos et al. 2009b). A paradigmatic case has been the proliferation of open dumps and their positive impact on large gulls' (*Larus* spp.) population growth, until being considered as a pest in several regions (e.g. Belant 1997; Rock 2005).

When the food supply available in an area throughout a year stops being a limiting factor, the resident strategy is normally more advantageous than the migratory one (Berthold 2001). In Europe, the Bay of Biscay and the Atlantic coasts of Iberia host a remarkable population of non-breeding gulls, apart from a considerable resident population of the yellow-legged gull (*Larus michahellis*), with currently more than 80,000 pairs (Bermejo and Mouriño 2003). The yellow-legged gulls within the region forage on marine prey as well as refuse tips, as the latter is an abundant, stable feeding source (Moreno et al. 2009; Arizaga et al. 2011). The proliferation of large open dumps during the last few years is hence likely to have had a considerable impact not only on the population increase (e.g. via increasing the productivity and/or survival) observed for the yellow-legged gull, but also on reducing foraging distance to a minimum (Arizaga et al. 2010), thus favouring resident behaviours (Munilla 1997).

The effects of closing a dump on the biology and ecology of gulls are understood mainly in relation to breeding dynamics (Pons 1992; Oro et al. 1995). By contrast, less is known about the extent to which refuse tips have a decisive role on dispersal (Sol et al. 1995). Previous studies carried out in the Mediterranean hypothesised that a high food supply in the Atlantic area during the non-breeding season (mainly in autumn and winter) is the reason why Mediterranean yellow-legged gulls travel to the Bay of Biscay and the Atlantic Iberian coast after breeding (Martínez-Abrain et al. 2002) and is also why gulls breeding in the latter areas are resident (Munilla 1997). The growing trend of closing down open dumps and/or deterring access to food at refuse sites in the southeastern Bay of Biscay provided us with a suitable

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scenario for testing the role of dump management on the movement patterns of resident gull populations on a local scale. Dispersal of first-year gulls in this population is low, with most moving less than 50 km from their natal site (Arizaga et al. 2010). Older individuals also remain near breeding sites all year round (J. Arizaga, unpublished data). Long-distance displacements are rare, and they have always been recorded within Iberia (Arizaga et al. 2009b, 2010). Therefore, the population can be considered as resident.

Our aim here was to test whether the closure of a large dump and the use of falconry to deter gull access to refuse in two others, within the southeastern Bay of Biscay, affected the foraging distance of local resident gulls. If these gulls depend mainly on refuse tips, dump management should have a strong impact on foraging distance, as the movement patterns of gulls are thought to be related to foraging opportunities on a local scale.

## Material and methods

The study was carried out within the southeastern Bay of Biscay, a region with a yellow-legged gull population of more than 4,000 pairs (Arizaga et al. 2009a). During the breeding season of 2005 to 2011, 1,808 nestlings of ca. 20 days old were ringed with both darvic PVC with individual alphanumeric codes and metal rings at three nearby colonies in Gipuzkoa, southeastern Bay of Biscay. These were Ulia, Santa Clara and Guetaria (Table 1; Fig. 1). The protocol applied when ringing in the colonies was orientated towards reducing the stress suffered by the chicks (Cantos 2000).

Encountering data on gulls seen alive (sighting data) or dead (true recoveries) after they leave the colonies were compiled from July 2005 to February 2012, both by our team and by birdwatchers who sent data to us. From 3,620 data compiled, most (3,613) were sighting data; thus, only a marginal fraction ($n=7$) was relative to gulls found dead. Collected data consisted of distance from hatching to sighting site, in kilometers. From 3,620 "recaptures", 643 (17.8 %) were compiled by one observer who noted the dates when he was in the field counting gulls (i.e. for whom the sampling effort around the colonies was controlled). We observed no significant correlation between the two factors, i.e. sampling effort and number of gulls found at more than 50 km from their natal sites ($r=-0.436$, $P=0.328$, $n=7$, considering the data from the first-year gulls), indicating that the effort did not affect the estimation of foraging distance.

**Table 1** Number of nestlings ringed each year and seen in the subsequent winter (October–January) according to age categories

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|
| Ringed | 40 | 246 | 297 | 301 | 333 | 322 | 269 |
| Observed | | | | | | | |
| 1st year | 10 | 95 | 121 | 140 | 140 | 75 | 77 |
| 2nd year | | 13 | 75 | 81 | 102 | 55 | 81 |
| 3rd year | | | 9 | 65 | 72 | 54 | 78 |
| 4th year | | | | 7 | 66 | 37 | 75 |
| 5th year | | | | | 6 | 30 | 46 |
| 6th year | | | | | | 3 | 34 |
| 7th year | | | | | | | 5 |

Yellow-legged gulls in the region are observed to feed frequently in dumps situated close to the coastline (A. Herrero and A. Aldalur, personal observation). The colonies of Gipuzkoa, where the study was carried out, have three main dumps in the vicinity: San Marcos (municipality of Donostia-S. Sebastián), Urteta (Zarauz) and Zaluaga (St. Pée Sur Nivelle) (Fig. 1). All are situated at a distance of less than 50 km from the colonies. The main events to consider in relation to the management of these dumps were as follows:

1. October 2008: The San Marcos dump closed, so gulls began to explore alternative sources until they found and began to use the Urteta dump.
2. January 2010: implementation of falconry at the Urteta dump: This turned out to be very successful, and as a consequence, gulls stopped using this dump.
3. October 2010: For 4 months from this date, falconry was also used at the Zaluaga dump. During this period, gulls did not visit this dump despite having been observed in earlier periods (A. Herrero, personal observation). From January 2011, however, falconry was abandoned and gulls began to feed at this dump again.

Movement patterns of yellow-legged gulls within the Bay of Biscay seem to be fairly constant throughout the year although some small intermonth variations exist (Arizaga et al. 2010). Therefore, we used only data collected during the same 4-month period each year (from October to January inclusive). Hereafter, we will call this period the "winter period", so the sighting data from the winter of 2005 were those obtained from October 2005 to January 2006. This period was chosen in line with the main dump management events in Gipuzkoa (Fig. 2).

Each individual was considered only once per winter, and if seen more than once in a particular winter, we considered the furthest distance from hatching to sighting site. Since an individual may be seen in several subsequent winters (i.e. from year to year), we also considered age categories (Table 1). Thus, we considered an individual born in 2005 and seen the subsequent winter as a first year, but as a second year if seen during the winter of 2006. As fourth-year gulls or older birds were not in the population up to the winter of 2008, we only considered gulls of first, second and third year for the study, since we were interested in birds being in the population


**Fig. 1** Location of the sampling colonies and fishing harbours in Gipuzkoa, as well as the three main dumps situated at a distance of less than 50 km from sampling colonies

before, during and after the winter of 2008, i.e. the winter when refuse management began within the region (Fig. 2).

To test whether on average gulls moved longer distances during the winter in which all dumps were closed (2010), firstly, we compared mean maximum distance throughout the whole study period (2005–2011) with distance travelled during the winter of 2010. Distances were calculated with ArcGIS 9.3. Age categories were considered separately for the analyses. Subsequently, we created a null model for each age class in order to describe movement patterns during the entire study period. Mean Euclidean distance from natal site to sighting site was re-sampled 1,000 times using Monte Carlo simulations (with replacement) implemented in PopTools 3.2.5. (Hood 2011). Moreover, we created a second model for each age class only for the winter of 2010. Again, mean distance was calculated and re-sampled 1,000 times using Monte Carlo simulations. Finally, we compared mean distance of the null model with that which considered only the data from the winter of 2010, for which the overlap between the confidence interval was tested.

## Results

Overall, most gulls moved less than 50 km from their natal sites (median 31.6 km, first and third quartile 17.3 and

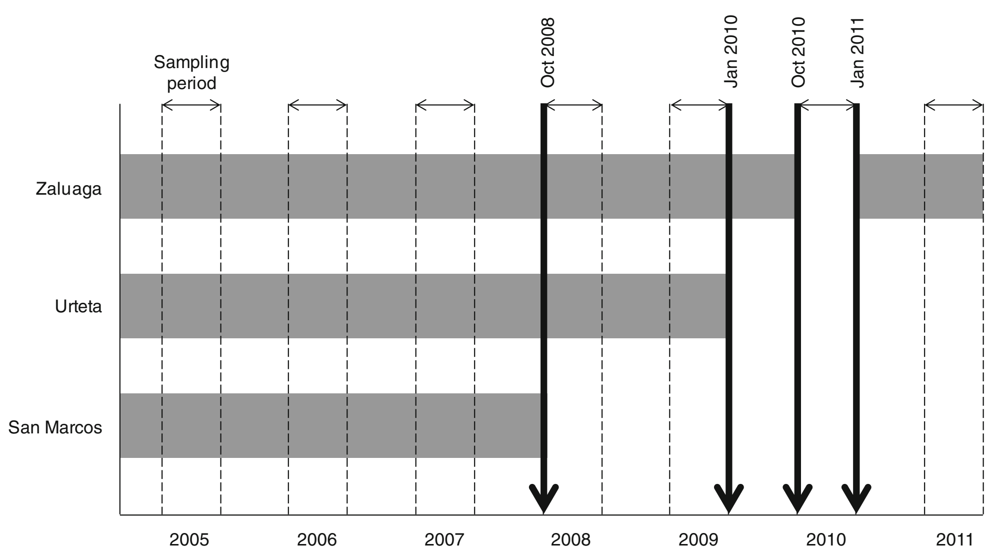


**Fig. 2** Schedule of refuse management at the three dumps in the region where the study was carried out. *Vertical arrows* indicate main refuse management events. *Grey bands* represent the periods when gulls were able to access food at each dump. The sampling period is from October to January of the following year

**Table 2** Percentage of yellow-legged gulls seen at more than 50 km from their natal sites, in relation to their age class (from first to third year)

| Age class | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | All |
|---|---|---|---|---|---|---|---|---|
| 1st year | 40.0 | 24.2 | 20.7 | 18.6 | 26.4 | 52.0 | 39.0 | 28.0 |
| 2nd year | | 15.4 | 28.0 | 23.5 | 22.5 | 56.4 | 32.1 | 30.0 |
| 3rd year | | | 33.3 | 10.8 | 16.7 | 46.3 | 19.2 | 22.3 |

65.3 km, respectively). The proportion of gulls that moved more than 50 km from their natal site was 30 % with the remaining 70 % staying within a 50-km radius (Table 2). However, during the winter of 2010, a higher percentage of gulls was found at more than 50 km from their natal site (overall 51.6 %, Table 2). The Monte Carlo analyses revealed that gulls were observed at greater distances during the winter of 2010, i.e. when all dumps had been closed within the region (Fig. 3). This difference was significant for third-year individuals (Monte Carlo simulations: groups of first and second-year $P>0.05$, third year $P<0.001$).

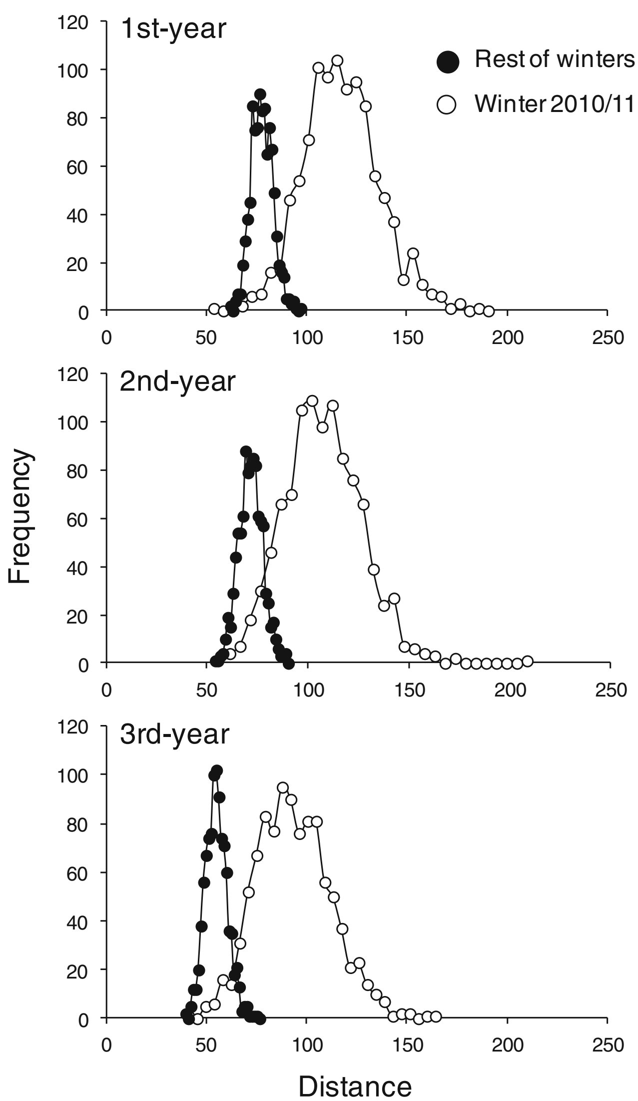


**Fig. 3** Frequency distributions of Monte Carlo simulations for the mean distance from natal site (in km) to the farthest sighting site where each individual was seen during winter. Age groups were considered separately. In each case, data were boot-strapped 1,000 times (with replacement)

## Discussion

Seasonal variations on marine prey availability around breeding colonies are considered to be one of the main factors explaining the movement pattern of seabirds and of large gulls in particular (Spear 1988; Munilla 1997). However, it is less well understood to what extent refuse tips can also have an impact on or modify such patterns (but see Ramos et al. 2009a, b).

Overall, only ca. 30 % of the gulls were seen at a distance of more than 50 km from their natal site during the winter period. This supports the theory that most birds remained close to their hatching colonies throughout the year. However, in the winter when access to the three main dumps within the region was constrained (one was closed and the others used falconry to deter gulls from landing), gulls moved to more distant regions. There was an increase in the proportion of local gulls which decided to explore areas farther away from their natal site. This supports the hypothesis that management of refuse tips on a local scale has direct implications on the movement patterns of local yellow-legged gulls.

Yellow-legged gulls in the southeastern Bay of Biscay have been reported to depend highly on marine prey (Arizaga et al. 2013). A fraction of such marine prey comes from fish discards (Arizaga et al. 2011), so a winter with abnormally low activity at local fisheries would also explain our results. However, during the winter of 2010 to 2011, when access to refuse tips was difficult for gulls, the activity of fisheries within the region increased (Fig. 4). The increasing dispersal

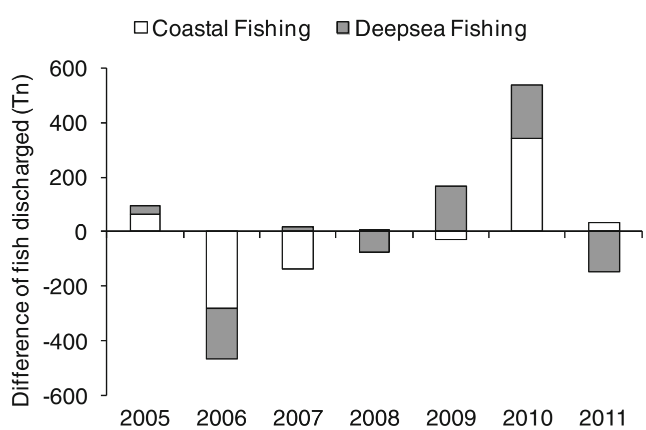


**Fig. 4** Amount of fish discharged (difference in relation to mean values) in one of the main fishing harbours of Gipuzkoa (source: Pasaia harbour) from October to January of the following year

registered during that winter was therefore not due to a decrease in fish availability.

In conclusion, we found that gulls made longer displacements when all the dumps within a considerable buffer area (here, a 50-km radius) around the colonies were closed or inaccessible due to the use of deterrents. This highlights the fact that refuse managers must consider a regional or supralocal (municipal) area in order to guarantee that this type of food is definitively inaccessible to gulls and hence that their biological pattern and population dynamics are not influenced by artificially provided food such as refuse.

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