The impact of non–local birds on yellow–legged gulls (*Larus michahellis*) in the Bay of Biscay: a dump–based assessment

O. Jordi, A. Herrero, A. Aldalur, J. F. Cuadrado & J. Arizaga

Jordi, O., Herrero, A., Aldalur, A., Cuadrado, J. F. & Arizaga, J., 2014. The impact of non–local birds on yellow–legged gulls (*Larus michahellis*) in the Bay of Biscay: a dump–based assessment. *Animal Biodiversity and Conservation*, 37.2: 183–190.

Abstract

*The impact of non–local birds on yellow–legged gulls (*Larus michahellis*) in the Bay of Biscay: a dump–based assessment*.– Understanding how animals exploit non–natural feeding sources such as garbage dumps is necessary from many perspectives, including conservation, and population dynamics and management. Several large predatory gulls (*Larus* spp.) are among the species which most clearly benefit from using dumps. The yellow–legged gull (*L. michahellis*) is the most abundant gull in the southwestern Palaearctic, and its fast population increase until at least the 2000s was partly due large waste dumps becoming more numerous. The Bay of Biscay is an area that hosts resident local and also wintering non–local yellow–legged gulls. Using data collected over a period of eight years (bird counts, identification of colour–ringed individuals) at four dumps situated within a 60–km radius from the colonies of Gipuzkoa (southwestern Bay of Biscay), we aimed to answer: (1) the origin of gulls using dumps at the Bay of Biscay; (2) the impact of local and non–local gulls at these dumps; (3) the possible age–dependent use of these sites; and (4) the possible seasonal fluctuations in the use of dumps by gulls. Gulls in our area (study dumps) came from nearby colonies in Gipuzkoa, Atlantic Iberia, the Mediterranean region, and other areas such as Atlantic France and inland colonies (Navarra, Germany). Our study dumps seemed to be used mostly by local gulls.

Key words: Bird counts, Colour–ring, Generalist foragers, Gipuzkoa, Food availability, Trophic ecology.

Resumen

*El impacto de los individuos no locales en la gaviota patiamarilla (*Larus michahellis*) en el Golfo de Vizcaya: una estimación a partir de vertederos.*– Es necesario comprender la forma en que los animales explotan los recursos tróficos de origen no natural, como es el caso de los vertederos, desde múltiples perspectivas como la conservación, la dinámica de poblaciones y la gestión. Son varias las especies de gaviotas depredadoras de gran tamaño (*Larus* sp.) las que indudablemente se benefician de utilizar los vertederos. La gaviota patiamarilla (*L. michahellis*) es la especie de gaviota más abundante del Paleártico sudoccidental y el rápido crecimiento de sus poblaciones hasta al menos la primera década del siglo XXI se debe, parcialmente, al aumento de vertederos. El Golfo de Vizcaya es una zona que alberga gaviotas locales residentes y gaviotas invernantes procedentes de otras zonas. A partir de los datos obtenidos en censos y avistamientos de gaviotas marcadas con anillas de color que se recopilaron durante un periodo de ocho años en cuatro vertederos situados en un radio de 60 km desde las colonias de cría en Gipuzkoa, se trató de responder a las siguientes cuestiones: (1) el origen de las gaviotas que usan los vertederos en el Golfo de Vizcaya; (2) el impacto de los individuos locales y no locales en estos vertederos; (3) la posibilidad de que exista un uso distinto según la edad y (4) la posibilidad de que haya fluctuaciones estacionales en el uso de los vertederos. Las gaviotas en los vertederos estudiados provienen de las colonias costeras cercanas de Gipuzkoa, la zona atlántica de la península Ibérica, la región mediterránea y otras zonas como la costa atlántica de Francia y las colonias continentales (Navarra y Alemania). Parece que los vertederos de nuestro estudio fueron utilizados, principalmente, por aves locales.

Palabras clave: Censos, Anilla de color, Consumidores generalistas, Gipuzkoa, Disponibilidad de alimento, Ecología trófica.

Received: 28 V 14; Conditional acceptance: 6 VII 14; Final acceptance: 7 IX 14

Olga Jordi, Alfredo Herrero, Asier Aldalur, Juan F. Cuadrado, Juan Arizaga, Dept. of Ornithology, Aranzadi Sciences Society, Zorroagagaina 11, E20014 Donostia (S. Sebastián), España (Spain).

Corresponding author: J. Arizaga. E–mail: jarizaga@aranzadi–zientziak.org

ISSN: 1578–665 X
eISSN: 2014–928 X

Introduction

Human activity often produces a super–abundance of food that is exploited by generalist animal foragers (Oro et al., 1995; Giaccardi & Yorio, 2004; Oro et al., 2013; Heath et al., 2014). Dumps constitute a paradigmatic case of this phenomenon. The availability of huge amounts of organic waste attracts multiple species of animals, so some dumps can give rise to concentrations of up to many thousands of individuals (Donázar, 1992; Pons, 1992; Tortosa et al., 2002; Admasu et al., 2004).

Dumps promote large changes in several wildlife aspects, such as demography (Newton, 2013), dispersal and migration (Newton, 2008), trophic ecology (Ramos et al., 2009), and diseases (Monaghan et al., 1985). In parallel, animal concentrations around particular dumps often generate socio–economic (Belant, 1997; Raven & Coulson, 1997; Rock, 2005), sanitary (Monaghan et al., 1985; Ramos et al., 2010), and ecological problems (Rusticali et al., 1999; Vidal et al., 2000; Oro et al., 2005). In attempts to solve this situation, managers have tried to control over–population using a variety of methods, such as culling. These approaches are often of doubtful efficiency (Bosch et al., 2000; Álvarez, 2008) and can even promote undesired effects (Newton, 2013). Alternatively, or complementarily, managers have used methods such as falconry to deter gulls from sites such as dumps (Arizaga et al., 2013a).

Several large predatory gulls (*Larus* spp.) are among the species that benefit most from dumps (Olsen & Larson, 2004). As opportunistic foragers, they exploit a feeding source that has promoted rapid growth rates in their populations (Duhem et al., 2002; Skorka et al., 2005; Duhem et al., 2008). The yellow–legged gull (*L. michahellis*) is the most abundant gull in the southwestern Palaearctic (Olsen & Larson, 2004). Its fast population increase until, at least, the 2000s (Arizaga et al., 2009; Molina, 2009) was partly due to the generalization of large dumps (Duhem et al., 2008) and some colonies have been strongly linked to this type of food (Ramos et al., 2009; Ramos et al., 2011). Other colonies, that depend more on marine prey or other types of natural feeding sources, also forage, to a greater or lesser extent, on waste from dumps (Moreno et al., 2009; Arizaga et al., 2013b). Dumps, in consequence, play a key role for the species.

The yellow–legged gull population is divided into several subspecies that have different migratory behaviour (Olsen & Larson, 2004). Populations from Atlantic Iberia (mostly attributed to belong to *L. m. lusitanius*) are resident, and populations from the Mediterranean (belonging to *L. m. michahellis*) are partially migratory (Munilla, 1997; Arizaga et al., 2010; Galarza et al., 2012). The latter overwinter in part within the Bay of Biscay (Martínez–Abrain et al., 2002). Dumps within this region offer a great foraging opportunity to gulls but the use of these sites by local and non–local gulls is still poorly understood (Álvarez, 2008; Galarza et al., 2012). Here we aimed to determine (1) the origin of gulls using dumps in the Bay of Biscay, (2) the impact of local and non–local gulls at these dumps, (3) the possible age–dependent use of these sites, and (4) the possible seasonal fluctuations in the use of dumps by gulls.

Using data collected over a period of eight years at four dumps in the south–eastern Bay of Biscay area, we aimed to answer these questions. We accordingly increased our understanding of dump use and the population structure of the yellow–legged gull within this region, where local and non–local individuals coexist for several months each year.

Material and methods

Study area and data collection

We considered the dumps situated within a radius of 60 km from the colonies of Gipuzkoa province (north of Spain). These colonies are situated in the east–most distribution range of the yellow–legged gull, subspecies *L. m. lusitanius*, in the Bay of Biscay (Olsen & Larson, 2004).

From January 2006 to February 2014, the species was surveyed foraging at four dumps within this 60–km radius: S. Marcos, Urteta, Zaluaga and Sasieta (fig. 1). There were two other dumps within this radius (Igorre, Lemoiz) where the species was known to occur, but they were not included in the analyses due to the lack of surveys. The use of the four study dumps by the yellow–legged gull varied during the study period, in accordance with dump management and the amount of food (waste) available at each site (Arizaga et al., 2013a).

At each dump, the yellow–legged gull population size was assessed by means of visual counts. These were always done from the same site at each dump and by the same observer. The time invested to count gulls at each dump was also constant so, overall, the sampling effort at each dump remained constant. Counts from days when gulls were flying around the dump and/or when we observed that they were continuously moving/flying, due to the use of falconry or other dissuasive methods, were not considered for our analyses.

The yellow–legged gull was the dominant gull among the white–headed gull species at all dumps, and therefore the occurrence of other species could be considered marginal. The second gull in terms of numbers was the Lesser Black–backed Gull (*L. fuscus*) but it comprised ca. < 5% of the counts. Total gull counts were therefore considered to provide a good estimate of the yellow–legged gull population at each dump.

Apart from counts, our databank also contained sightings of colour–ringed gulls seen alive by us or reported by birdwatchers. These included data from colour–ringed gulls seen at both the study dumps and in sites outside these dumps (*e.g.* rivers, harbors, beaches, etc.). We only considered data from individuals ringed as chicks. Sighting data were used to determine the origin of the gulls and to quantify their relative amount with regard to the entire population. Finally, we compiled the number of chicks ringed at the colonies from which ringed gulls were seen at our study dumps.

Overall, data were collected from January of 2006 to February of 2014.

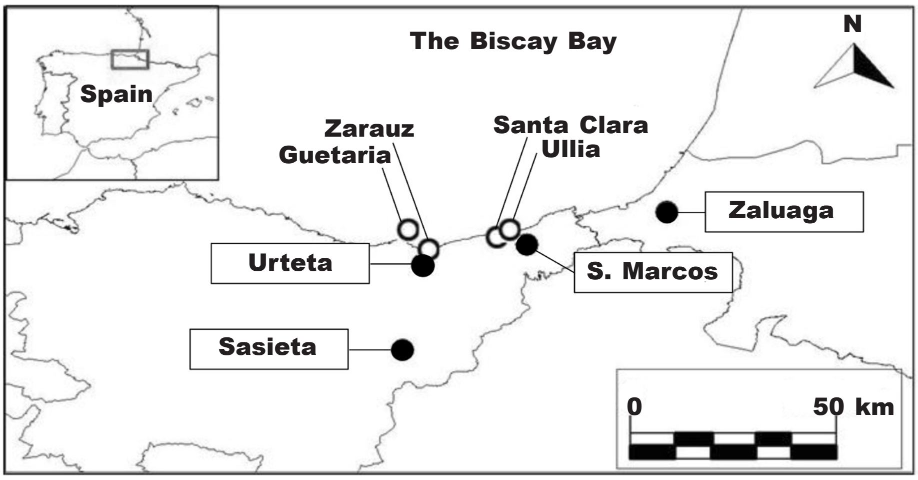

Fig. 1. Location of the study dumps (dark dots) situated at less than 60 km from the reference colonies (open dots) in Gipuzkoa.

Fig. 1. Localización de los vertederos estudiados (puntos negros) situados en un radio de 60 km desde las colonias de referencia (puntos en blanco) en Gipuzkoa.

Data analyses

We pooled years and dumps for all the analyses due to the relatively low sample size (number of counting days) at most dumps (table 1).

To examine the origin sites of gulls visiting our study dumps, we built a table with the number of individual colour–ringed gulls and the total number of origin colonies detected at each dump. Colonies were grouped into four areas of origin: Gipuzkoa (colonies situated at < 60 km), Atlantic, Mediterranean, and others (Atlantic France, inland Iberia, central–western Europe).

We also checked whether the use of the dumps varied between age groups and in relation to the regions of origin. To do this, we considered data obtained both at and outside the study dumps, within a radius of 60 km. We considered five age groups: 1st–year, 2nd–year, 3rd–year, 4th–year, and older (> 4 year) birds. An age category was considered as the year elapsing from July (when chicks fledge) through to June the following year. Groups from two origins were considered: local gulls (Gipuzkoa colonies) and gulls of Mediterranean origin. The gulls from other origins (Atlantic Iberia, Others) were not included in this analysis due to low sample size (< 10 gulls per age class). For each category of origin (Gipuzkoa or Mediterranean), we conducted a chi–square test to see whether the relative number of gulls at and outside the dumps varied between age classes. Standardized residual values from this test were used to identify significant biases from a distribution assuming the same proportion of counts between zones and group. Values > 3 indicate significant differences (Agresti, 2002).

To estimate the yellow–legged gull population size at each dump, we divided the year into two periods, the breeding (January to June) period, and the non–breeding period (July to December). The breeding period corresponded to the time when the occurrence of yellow–legged gulls of Mediterranean origin is minimal (Galarza et al., 2012), while the non–breeding period corresponded to a period when local resident gulls (Arizaga et al., 2010) live in sympatry with yellow–legged gulls from other origins (Galarza et al., 2012). To analyse whether the population size of yellow–legged gulls varied between these periods and between dumps, we conducted a generalized linear model (GLM) on bird counts (log–transformed) with dump and period as factors. Bird counts were log–transformed to fit the normal distribution (K–S test: $P > 0.05$). A linear–link function was used for the GLM.

All analyses were run using the software SPSS v.21.0.

Results

A total of 1226 colour–ringed gulls were observed. We detected 38 origin colonies: four in Gipuzkoa, nine in Atlantic Iberia, 22 in the Mediterranean region and three at other sites (Atlantic France, inland Iberia, central–western Europe) (table 2; fig. 2).

Considering the number of chicks ringed at the origin colonies (table 3), we observed that 39.8% of the chicks ringed at the colonies in Gipuzkoa were seen at our study dumps (all the year is considered here). This proportion was lower for the other origin zones: Atlantic Iberia, 5.6%; Mediterranean, 1.8%; others: 4.2%.

Regarding the use of our dumps between age classes in relation to their origin region, we obser-

Table 1. Number of survey (counting) days at each dump. We show the total number of visits and also those when birds were present. (Data from 2014 collected only until February.)

Tabla 1. Número de días de censo (conteo) en cada vertedero. Mostramos tanto el total de visitas como las visitas en que se detectaron gaviotas. (Los datos de 2014 se obtuvieron solo hasta febrero.)

			No. counts (> 0)		No. counts (all)	
Dump	Coordinates	Year	Jan–Jun	Jul–Dec	Jan–Jun	Jul–Dec
S. Marcos	43º 18' N – 01º 56' W	2006–2007	3	2	3	2
Urteta	43º 15' N – 02º 10' W	2006–2009	30	15	25	15
Zaluaga	43º 23' N – 01º 34' W	2009–2014	44	55	33	54
Sasieta	43º 02' N – 02º 13' W	2012–2014	8	4	2	4

ved that the proportion of each age category within and outside the dumps did not vary for any of the origin categories considered (Gipuzkoa: $\chi^2 = 7.896$, $P = 0.095$; Mediterranean: $\chi^2 = 7.896$, $P = 0.095$). Overall (data obtained at and outside the study dumps pooled), we detected that the number of 4^{th}year gulls seen at our dumps was proportionally lower for birds of Mediterranean origin. This finding was reversed for older (> 4 years) birds ($\chi^2 = 49.887$, $P < 0.001$; fig. 3)

The population size did not vary between periods but differed between dumps (Period: Wald $\chi^2 = 0.126$, $P = 0.723$; Dump: Wald $\chi^2 = 21.642$, $P < 0.001$; Period × Dump: Wald $\chi^2 = 2.463$, $P = 0.482$; fig. 4). This difference was due to the higher population at Sasieta (> 3,000 gulls) than at the other three dumps (1,000–2,000 gulls) (table 4; fig. 4).

Discussion

The origin of yellow–legged gulls at four dumps near the southeastern Bay of Biscay was diverse. It ranged from Gipuzkoa (local resident gulls; *L. m. lusitanius*) and other colonies along the Bay of Biscay from northwestern Iberia (also *L. m. lusitanius*) to northwestern France (*L. m. michahellis*; Yésou, 1991), to the Mediterranean and a few inland colonies, including inland Iberia and central–western Europe (*L. m. michahellis*) (Bermejo & Mouriño, 2003; Olsen & Larson, 2004).

Overall, the results are in accordance with the migration patterns described for these two yellow–legged gull subspecies (Munilla, 1997; Olsen & Larson, 2004; Arizaga et al., 2010; Galarza et al., 2012). Thus, while *L. m. lusitanius* is mostly resident, with only a slight fraction moving > 60 km from their natal sites (Arizaga et al., 2010), *L. m. michahellis* migrates to overwinter mostly within the Bay of Biscay (*e.g.*, Galarza et al., 2012). However, considering only the latter subspecies, we did not detect gulls from south–western Iberia, northern Africa (except Algeria), or the central–eastern Mediterranean. Although in some of these areas (*e.g.* northern Africa) few gulls are ringed, this is not the case in others (*e.g.* Italy) (Spina & Volponi, 2008). Therefore, it can be reasonably stated that the central–eastern Mediterranean and the south–western Iberian gulls are rare visitors to our dumps and hence in the south–eastern Bay of Biscay. The occurrence of sufficient food in these two extensive regions would prevent local birds from having the need to move north to the

Table 2. Number of individually colour–ringed yellow–legged gulls (each bird considered only once) detected at the study dumps. We show how many of these gulls were ringed in each origin: [1] Atlantic France (Ré island), inland Iberia (Navarra), central–western Europe (Germany).

Tabla 2. Número de gaviotas marcadas con una anilla de color (cada ejemplar solo se tuvo en cuenta una vez) que se detectaron en los vertederos estudiados. Se muestra cuántas de estas gaviotas se anillaron en cada región de origen: [1] Costa atlántica de Francia (isla de Ré), interior de la península ibérica (Navarra) y Europa centrooccidental (Alemania).

	Origin colonies			
Individual rings	Gipuzkoa (< 60 km)	Atlantic Iberia	Mediterranean	Others*
1,226	930	127	166	3

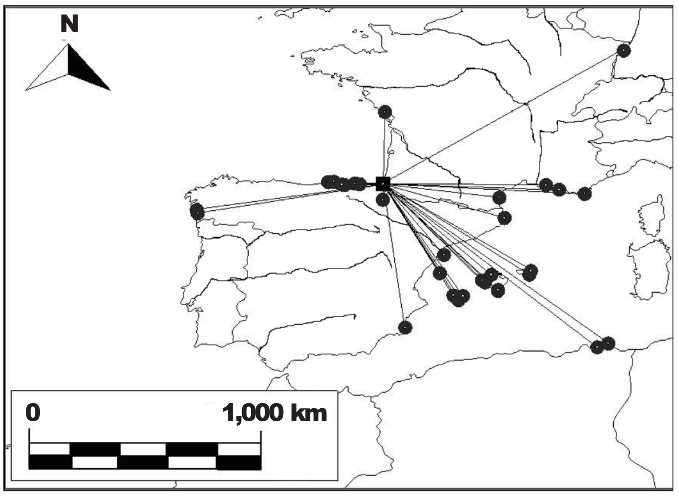

Fig. 2. Origin (dots) of yellow–legged gulls at dumps shown in fig. 1 (square) situated less than 60 km from the colonies in Gipuzkoa. Origins reported using individuals colour–ringed as chicks. The administrative limits are shown in order to facilitate the location of the colonies. Moreover, we also show the main rivers.

Fig. 2. Origen (puntos) de las gaviotas patiamarillas que se observaron en los vertederos de la fig. 1 (cuadrado) situados en un radio inferior a 60 km desde las colonias de Gipuzkoa. Los orígenes se determinaron a partir de aves marcadas cuando eran pollos con una anilla de color. Se muestra el límite administrativo de los estados con el fin de facilitar la localización de las colonias. Además, se muestra el cauce de los ríos más importantes.

Biscay Bay area. For instance, the areas surrounding Cádiz Bay, and the Guadalquivir and other nearby river mouths are among the most nutrient productive areas in south–western Europe (Huertas et al., 2006).

The presence of gulls at dumps as compared to sites at a distance from the dumps did not vary between age classes. This was independent of the region of origin and suggests that the use of the dumps was not age–dependent. The use of refuse tips as a food resource was general for all age classes within the region. This result contrasts with findings from earlier studies carried out in the Bay of Biscay, where adult Mediterranean yellow–legged gulls were observed to be proportionally more abundant at dumps than young, sub–adult gulls (Galarza et al., 2012). A possible reason for this difference is a bias associated with local conditions close to our study dumps. We considered a relatively small survey area, so it is possible that the presence of gulls outside the dumps but still rather close to them may be conditioned by the use of these dumps. Thus, some sighting points around or close to dumps may be used as resting areas by the same gulls that have fed in the dumps.

We also observed that, up to the 4th year, yellow–legged gulls of Mediterranean origin become progressively less abundant than local yellow–legged gulls, indicating that older gulls of Mediterranean origin tend to disappear from our area. This is likely due to the fact that adult Mediterranean yellow–legged gulls may remain near their breeding sites during the non–breeding period (Martínez–Abrain et al., 2002; Ramos et al., 2011). The proportionally higher

Table 3. Number of individually colour–ringed yellow–legged gulls (each bird considered only once) detected at our study dumps and number of chicks ringed in the origin colonies of these gulls. We show in brackets the number of colour–ringed gulls coming from colonies from which the total number of chicks ringed was provided: [1] See caption of table 2; [2] During the years in which the gulls seen at our dumps hatched.

Tabla 3. Número de gaviotas patiamarillas marcadas con una anilla de color (cada ejemplar solo se tuvo en cuenta una vez) que se detectaron en los vertederos estudiados y número de pollos anillados en las colonias de origen. En paréntesis, se indica el número de gaviotas con anilla de color provenientes de colonias para las que se pudo saber el total de pollos anillados: [1] Ver cabecera de la tabla 2; [2] Durante los años en que nacieron los pollos que fueron vistos en los vertederos estudiados; .

Origin colonies	Ringed gulls seen	Chicks ringed [2]
Gipuzkoa (< 50 km)	930 (930)	2,339
Atlantic Iberia	127 (126)	2,267
Mediterranean	166 (141)	7,586
Others [1]	3 (2)	48

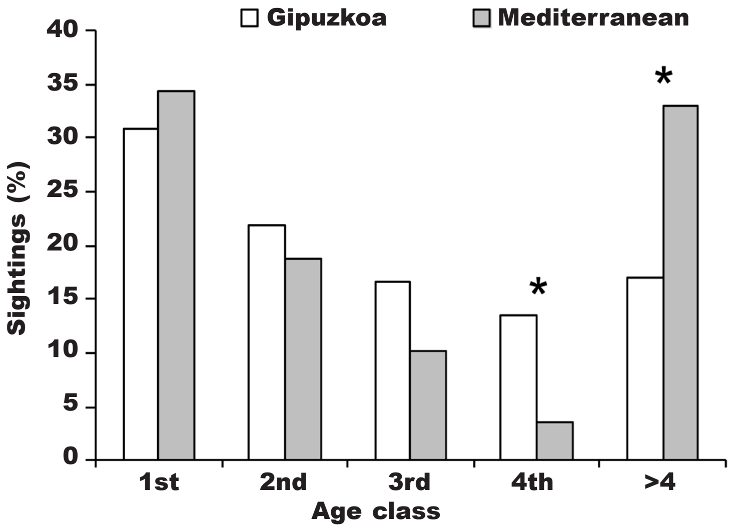

Fig. 3. Relative abundance (percentage) of gulls at the study dumps and their surroundings (within a 60–km radius) in relation to their age class and origin. The symbol (*) indicates significant differences between the two origins for each age class in relation to an expected distribution similar for the two regions.

Fig. 3. Abundancia relativa (porcentaje) de gaviotas en los vertederos estudiados y su entorno (en un radio de 60 km) en relación con la edad y el origen. El símbolo (*) indica la existencia de diferencias significativas entre ambos orígenes para cada edad en relación con una distribución esperada similar para ambas regiones.

percentage of adult Mediterranean gulls, compared to those from Gipuzkoa, is likely associated to the fact that, overall, ringing at the Mediterranean colonies has been done for longer and, therefore, a higher number of adult ringed birds of Mediterranean origin were still alive when the study was carried out.

Finally, we found no statistical evidence to support relevant fluctuations of gull abundances between dumps (except at Sasieta, where more birds were detected) or between seasons. With counts ranging between 1,000 and 2,000 individuals, and considering a breeding population at Gipuzkoa of ca. 1,000 pairs (Arizaga et al., 2009; Molina, 2009), which is known to depend on refuse tips to a relevant extent (Arizaga et al., 2013a, 2013b), it can be deduced that most gulls at our dumps were local. The

Table 4. B–parameters from a GLM used to test if the number (population size) of gulls varied among dumps and periods: D. Dump; P. Period; B. Breeding; NB. Non–breeding; [a] Reference values.

Tabla 4. Parámetros B de un modelo lineal general empleado para comprobar si el número (tamaño de la población) de gaviotas varió entre vertederos y periodos: D. Vertedero; P. Período; B. Crianza; NB. No crianza; [a] Valores de referencia.

Parameters	*B*	SE(*B*)	*P*
D: Sasieta	+ 0.425	0.183	0.020
D: Zaluaga	+ 0.136	0.095	0.152
D: S. Marcos	+ 0.080	0.241	0.741
D: Urteta	0[a]		
P: Breeding (B)	– 0.186	0.106	0.081
P: Non–breeding (NB)	0[a]		
Sasieta × B	+ 0.285	0.301	0.343
Sasieta × NB	0[a]		
Zaluaga × B	+ 0.185	0.128	0.150
Zaluaga × NB	0a		
S. Marcos × B	+ 0.123	0.310	0.693
S. Marcos × NB	0[a]		
Urteta × B	0[a]		
Urteta × NB	0[a]		

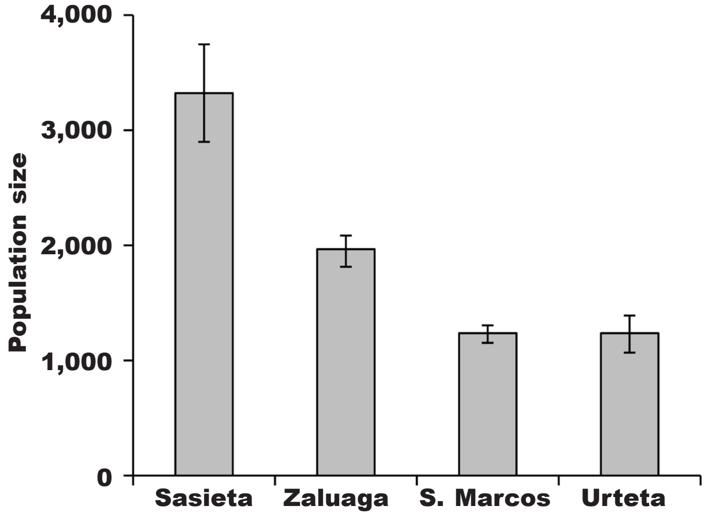

Fig. 4. Population size (mean ± SE) of the yellow–legged gull at four dumps situated within a 60 km radius of the colonies in Gipuzkoa.

Fig. 4. Tamaño de la población (media ± EE) de gaviota patiamarilla que utilizaron los cuatro vertederos situados en un radio de 60 km desde las colonias en Gipuzkoa.

higher number of gulls at Sasieta was probably due to the fact that there were no other dumps nearby during the survey period.

Acknowledgements

This research was funded by the Basque Government and the Gipuzkoa Regional Council. Many thanks to the people who provided the sighting data and those who provided data on the number of chicks ringed at various colonies, especially: N. Baccetti, A. Galarza, M. McMinn, J. Mouriño, G. Orizaola, B. Samraoui, B. Sarzo, V. Saravia, and the institutions Asociación Naturalista del Sudeste, Catalan Institute of Ornithology, Columbretes Islands Natural Reserve, LPO–Réserve Naturelle Lilleau des Niges, Equipo de Anillamiento Milvus–GOES, Ebro Delta Natural Park. J. A. Donázar and two referees provided very valuable comments that helped us to improve an earlier version of this work.

References

Admasu, E., Thirgood, S. J., Bekele, A. & Karen Laurenson, M., 2004. Spatial ecology of golden jackal in farmland in the Ethiopian Highlands. *African Journal of Ecology,* 42: 144–152.

Agresti, A., 2002. *Categorical Data Analysis.* Wiley. London.

Álvarez, C. M., 2008. *La problemática de las gaviotas en Asturias. El caso del Vertedero Central de COGERSA.* Principado de Asturias/COGERSA. Gijón.

Arizaga, J., Aldalur, A., Herrero, A., Cuadrado, J., Díez, E. & Crespo, A., 2013a. Foraging distances of a resident yellow–legged gull (*Larus michahellis*) population in relation to refuse management on a local scale. *European Journal of Wildlife Research* in press.

Arizaga, J., Galarza, A., Herrero, A., Hidalgo, J. & Aldalur, A., 2009. Distribución y tamaño de la población de la Gaviota Patiamarilla *Larus michahellis lusitanius* en el País Vasco: tres décadas de estudio. *Revista Catalana d'Ornitologia,* 25: 32–42.

Arizaga, J., Herrero, A., Galarza, A., Hidalgo, J., Aldalur, A., Cuadrado, J. F. & Ocio, G., 2010. First–year movements of Yellow–legged Gull (*Larus michahellis lusitanius*) from the southeastern Bay of Biscay. *Waterbirds,* 33: 444–450.

Arizaga, J., Jover, L., Aldalur, A., Cuadrado, J. F., Herrero, A. & Sanpera, C., 2013b. Trophic ecology of a resident Yellow–legged Gull (*Larus michahellis*) population in the Bay of Biscay. *Marine Environmental Research,* 87–88: 19–25.

Belant, J. L., 1997. Gulls in urban environments: landscape–level management to reduce conflict. *Landscape and Urban Planning,* 38: 245–258.

Bermejo, A. & Mouriño, J., 2003. *Gaviota Patiamarilla, Larus cachinnans.* In: Atlas de las aves reproductoras de España: 272–273 (R. Martí & J. C. del Moral, Eds.). DGCN–SEO/BirdLife, Madrid.

Bosch, M., Oro, D., Cantos, F. J. & Zabala, M., 2000. Short–term effects of culling on the ecology and population dynamics of the yellow–legged gull. *J.*

Appl. Ecol., 37: 369–385.

Donázar, J. A., 1992. Muladares y Basureros en la biología de la conservación de las aves en España. *Ardeola,* 39: 29–40.

Duhem, C., Bourgeois, K., Vidal, E. & Legrand, J., 2002. Food resources accessibility and reproductive parameters of Yellow–legged Gull *Larus michahellis* colonies. *Revue D Ecologie–La Terre Et La Vie,* 57: 343–353.

Duhem, C., Roche, P., Vidal, E. & Tatoni, T., 2008. Effects of anthropogenic food resources on yellow–legged gull colony size on Mediterranean islands. *Population Ecology,* 50: 91–100.

Galarza, A., Herrero, A., Domínguez, J. M., Aldalur, A. & Arizaga, J., 2012. Movements of Mediterranean Yellow–legged Gulls *Larus michahellis* to the Bay of Biscay. *Ringing and Migration,* 27: 26–31.

Giaccardi, M. & Yorio, P., 2004. Temporal patterns of abundance and waste use by kelp gulls (Larus dominicanus) at an urban and fishery waste site in northern coastal Patagonia, Argentina. *Ornitologia Neotropical,* 15: 93–102.

Heath, M. R., Cook, R. M., Cameron, A. I., Morris, D. J. & Speirs, D. C., 2014. Cascading ecological effects of eliminating fishery discards. *Nature Communications,* 5: 3893.

Huertas, I. E., Navarro, G., Rodríguez–Gálvez, S. & Lubián, L. M., 2006. Temporal patterns of carbon dioxide in relation to hydrological conditions and primary production in the northeastern shelf of the Gulf of Cadiz (SW Spain). *Deep Sea Research Part II: Topical Studies in Oceanography,* 53: 1344–1362.

Martínez–Abrain, A., Oro, D., Carda, J. & Del Señor, X., 2002. Movements of Yellow–Ledged Gulls *Larus [cachinnans] michahellis* from two small western Mediterranean colonies. *Atlantic Seabirds,* 4: 101–108.

Molina, B. E., 2009. *Gaviota reidora, sombría y patiamarilla en España. Población en 2007–2009 y método de censo.* SEO/BirdLife, Madrid.

Monaghan, P., Shedden, C. B., Ensor, K., Fricker, C. R. & Girdwood, R. W. A., 1985. *Salmonella* carriage by Herring gulls in the Clyde area of Scotland in relation to their feeding ecology. *J. Appl. Ecol.,* 22: 669–680.

Moreno, R., Jover, L., Munilla, I., Velando, A. & Sanpera, C., 2009. A three–isotope approach to disentangling the diet of a generalist consumer: the yellow–legged gull in northwest Spain. *Marine Biology,* 157: 545–553.

Munilla, I., 1997. Desplazamientos de la Gaviota Patiamarilla (*Larus cachinnans*) en poblaciones del norte de la Península Ibérica. *Ardeola,* 44: 19–26.

Newton, I., 2008. *The migration ecology of birds.* Academic Press. London.

– 2013. *Bird populations.* Collins New Naturalist Library, London.

Olsen, K. M. & Larson, H., 2004. *Gulls of Europe, Asia and North America.* Christopher Helm, London.

Oro, D., Bosch, M. , Ruiz, X. 1995. Effects of a trawling moratorium on the breeding success of the Yellow–legged Gull *Larus cachinnans*. *Ibis,* 137: 547–549.

Oro, D., De Leon, A., Minguez, E. & Furness, R. W., 2005. Estimating predation on breeding European storm–petrels (*Hydrobates pelagicus*) by yellow–legged gulls (*Larus Michahellis*). *Journal of Zoology,* 265: 421–429.

Oro, D., Genovart, M., Tavecchia, G., Fowler, M. S. & Martínez–Abraín, A., 2013. Ecological and evolutionary implications of food subsidies from humans. *Ecol. Lett.,* 16: 1501–1514.

Pons, J. M., 1992. Effects of changes in the availability of human refuse on breeding parameters in a Herring Gull *Larus argentatus* population in Brittany, France. *Ardea,* 80: 143–150.

Ramos, R., Cerda–Cuellar, M., Ramirez, F., Jover, L. & Ruiz, X., 2010. Influence of Refuse Sites on the Prevalence of *Campylobacter* spp. and *Salmonella Serovars* in Seagulls. *Applied and Environmental Microbiology,* 76: 3052–3056.

Ramos, R., Ramírez, F., Carrasco, J. L. & Jover, L., 2011. Insights into the spatiotemporal component of feeding ecology: an isotopic approach for conservation management sciences. *Diversity and Distributions,* 17: 338–349.

Ramos, R., Ramirez, F., Sanpera, C., Jover, L. & Ruiz, X., 2009. Diet of Yellow–legged Gull (*Larus michahellis*) chicks along the Spanish Western Mediterranean coast: the relevance of refuse dumps. *Journal of Ornithology,* 150: 265–272.

Raven, S. J. & Coulson, J. C., 1997. The distribution and abundance of *Larus* gulls nesting on buildings in Britain and Ireland. *Bird Study,* 44: 13–34.

Rock, P., 2005. Urban gulls: problems and solutions. *British Birds,* 98: 338–355.

Rusticali, R., Scarton, F. & Valle, R., 1999. Habitat selection and hatching success of Eurasian Oystercatchers in relation to nesting Yellow–legged Gulls and human presence. *Waterbirds,* 22: 367–375.

Skorka, P., Wojcik, J. D. & Martyka, R., 2005. Colonization and population growth of Yellow–legged Gull Larus cachinnans in southeastern Poland: causes and influence on native species. *Ibis,* 147: 471–482.

Spina, F. & Volponi, S., 2008. *Atlante della migrazione degli uccelli in Italia. Vol. 1: non–Passeriformi.* ISPRA–MATTM, Roma.

Tortosa, F. S., Caballero, J. M. & Reyes–López, J., 2002. Effect of Rubbish Dumps on Breeding Success in the White Stork in Southern Spain. *Waterbirds,* 25: 39–43.

Vidal, E., Medail, F., Tatoni, T. & Bonnet, V., 2000. Seabirds drive plant species turnover on small Mediterranean islands at the expense of native taxa. *Oecologia,* 122: 427–434.

Yésou, P., 1991. The sympatric breeding of *Larus fuscus*, *L. cachinnans* and *L. argentatus* in western France. *Ibis,* 133: 256–263.