

# Bias in little owl population estimates using playback techniques during surveys

I. Zuberogoitia, J. Zabala & J. E. Martínez

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## Summary

*Bias in little owl population estimates using playback techniques during surveys.*— To test the efficiency of playback methods to survey little owl (*Athene noctua*) populations we carried out two studies: (1) we recorded the replies of radio-tagged little owls to calls in a small area; (2) we recorded call broadcasts to estimate the effectiveness of the method to detect the presence of little owl. In the first study, we detected an average of 8.12 owls in the 30' survey period, a number that is close to the real population; we also detected significant little owl movements from the initial location (before the playback) to the next locations during the survey period. However, we only detected an average of 2.25 and 5.37 little owls in the first 5' and 10', respectively, of the survey time. In the second study, we detected 137 little owl territories in 105 positive sample units. The occupation rate was 0.35, the estimated occupancy was 0.393, and the probability of detection was 0.439. The estimated cumulative probability of detection suggests that a minimum of four sampling times would be needed in an extensive survey to detect 95% of the areas occupied by little owls.

Key words: Little owl, Survey methods, Presence Program, Detection efficiency, Vocal activity.

## Resumen

*Problemas en las estimas poblacionales de mochuelos cuando se realizan censos con reclamos.*— Se desarrollaron dos estudios diferentes para probar la eficiencia de los censos por medio de reclamos de mochuelos (*Athene noctua*): (1) un seguimiento intensivo de las respuestas a los reclamos de mochuelos radio-marcados en una pequeña área, (2) un estudio extensivo utilizando reclamos para estimar la eficiencia del método como herramienta para detectar la presencia de mochuelos. En el primer caso, se detectaron 8,12 mochuelos de media en un periodo de censo de 30', número cercano al tamaño de población real; además, se detectaron desplazamientos significativos de los mochuelos desde la posición inicial (antes de conectar el reclamo) a las posiciones siguientes durante la ejecución del reclamo. Sin embargo, tan sólo se detectó una media de 2,25 y 5,37 mochuelos en los primeros 5' y 10' respectivamente. En el segundo caso, se detectaron 137 territorios de mochuelos en 105 unidades de muestreo positivas. La tasa de ocupación fue de 0,35, la ocupación estimada de 0,393 y la probabilidad de detección de 0,439. La probabilidad acumulada estimada de detección sugiere que se precisarían de al menos cuatro muestreos en un estudio extensivo si se pretende detectar el 95% de las áreas ocupadas por mochuelos.

Palabras clave: Mochuelo común, Métodos de censo, Programa Presencia, Eficacia de detección, Actividad vocal.

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Iñigo Zuberogoitia, Estudios Medioambientales Icarus S. L., Pintor Sorolla 6 1º C, 26007 Logroño, España (Spain).— Jabi Zabala, Ihobe, Climate change and Biodiversity Area, Alameda Urquijo 36 6º, 48011 Bilbao, España (Spain).— José Enrique Martínez, Bonelli's Eagle Study and Conservation Group, Apdo. 4009, E-30080, Murcia, España (Spain).

Corresponding author: I. Zuberogoitia. E-mail: zuberogoitia@icarus.es

## Introduction

Owls are notoriously difficult to count because they are secretive and primarily nocturnal, and roost in concealed locations during the day (Mikkola, 1983). Monitoring of owl populations to date has generally taken long periods and the use of several tools to achieve accurate results. In current practice, population monitoring is most likely achieved in small areas where monitoring programmes are developed over long time periods. However, if we need to know the status of an owl guild in large areas, a balance must be made between time, effort, budget and the desired accuracy of the results we expect to achieve. Among the most effective methods to estimate owl populations in terms of cost and results is listening to owl calls during their activity period (see *i.e.* Zuberogoitia & Campos, 1997; Galeotti & Sacchi, 2001; Zuberogoitia, 2002; Martínez et al., 2007; Van Nieuwenhuyse et al., 2008). Although this is no simple task, it is worth the effort because knowledge of this aspect of bird behaviour (their responsiveness to survey methods) is necessary to optimize returns.

Playback of tape-recorded calls has been widely used to survey owl species worldwide and several studies rely on the use of elicited calls to systematically obtain data on the relative abundance of owls (*e.g.* Zuberogoitia & Campos, 1997; Martínez & Zuberogoitia, 2002; Escandell, 2005; Navarro et al., 2005; Crewe & Badzinski, 2006; Conway et al., 2008). However, whether this technique is effective in detecting some owl species is still a controversial issue (Martínez et al., 2002), and there are some aspects of this technique that require further research to determine applicability and possible shortcomings of the results.

For the last 20 years we have been studying owls in Bizkaia (Northern Spain), focusing our attention on owl distribution and status, survey methodologies and ecology (see Zuberogoitia, 2002). One of the target species, little owl (*Athene noctua*), was monitored to detect and document any possible population decline. Our main goal was to develop a replicable survey method to evaluate population trends. Based on our experience and a literature review we detected two main drawbacks in current practice and little owl survey methodologies. On one hand, abundance estimates obtained simply by listening to spontaneous calls or the response to broadcast calls are suspected of being affected by issues related with the studied population (Martínez & Zuberogoitia, 2004), and by methodological aspects such as the duration of the listening period. On the other hand, previous studies (Zuberogoitia & Campos, 1998; Johnson et al., 2009) and our own field experience suggest that presence/absence surveys based on broadcast calls generate an unknown number of omission errors (false absences) that could have important consequences for management. These errors could be overcome, or at least controlled, if the detection capability of the methods could be estimated.

We conducted two studies to throw light on these aspects. First, we carried out an intensive study on answers to calls of radio-tagged little owls in a small area

(approx. 1 km<sup>2</sup>) to determine individual and seasonal variations in owl detection and to assess how broadcast and listening times affect the number of owls estimated. Second, we conducted an extensive survey using call broadcasts to estimate the effectiveness of the method to detect the presence of little owl in the surveyed area.

## Study area

This study was carried out in two nested areas: the extensive survey covered the whole of the Basque Country (approx. 7,200 km<sup>2</sup>), whereas the intensive study was carried out in the Mungia valley in an area of approximately 1 km<sup>2</sup>.

The Autonomous Community of the Basque Country (lying between 42° and 43° N and 3° and 1° W) has two clearly defined areas (roughly north and south). The northern area runs along the coast of the Bay of Biscay, with its Atlantic climate and mild temperatures and an annual rainfall of 1,200–2,000 mm. The land there is mountainous and densely populated, with extensive urban and industrial areas, mainly located in valleys and on the gentler slopes. Forestry plantations (*Pinus radiata* and *Eucaliptus* spp.) have become widespread in the last 80 years, gradually replacing grazing land for extensively-reared livestock, traditional agricultural activities, and a few remnants of native forest. The second large area, of some 2,500 km<sup>2</sup>, lies to the south and is situated in an area of transition to the Mediterranean climatic region. The climate is Mediterranean and the landscape is dominated by arable lands, vineyards, Mediterranean scrub and holm-oak woods in the sloping areas.

The little owl population in the Atlantic area is divided into several small patches, which vary in density depending on the prevailing vegetation types, with areas of open fields and meadows harbouring the highest densities (see Zuberogoitia & Campos, 1997, 1998; Zabala et al., 2006). For the intensive radio-tracking study we selected one of these small population patches according to the following characteristics: 1) a high density of little owls: in the study area some fields contained seven pairs/km<sup>2</sup> (Zuberogoitia & Campos, 1998), 2) knowledge of the little owl population size and distribution, which had been surveyed previously (Zuberogoitia & Campos, 1997, 1998). This population was located in the Mungia valley, an area of 10 km<sup>2</sup> dominated by pastures for cattle, and small-holdings where the 1 km<sup>2</sup> intensive study area was located. The climate is rainy oceanic, with annual rainfall of around 1,500 mm, and annual average temperatures varying from 13.8°C to 12°C. Winters are mild and there is no summer drought.

## Methods

### Intensive study: changes in owl detection

We captured nine little owls using mist nets; they were then radio-tagged and radio-monitored between January and September 2004. All the little owls sur-



Fig. 1. Sample units (○) and detected territories of little owl (●) in the Basque Country in the breeding season of 2009.

*Fig. 1. Unidades de muestreo (○) y territorios de mochuelo detectados (●) en el País Vasco durante el periodo reproductor de 2009.*

vived throughout the study period (see Zuberogoitia et al., 2007, 2008). We radio-tracked these owls and listened to their calls simultaneously for a total of 250 hours, as described in more detail below. The tape recorder was set randomly in eight different points in the study area between February and June 2004, and it played three different sources of recordings of little owls (see Hardouin et al., 2004). The recording was always played for 30' in the first two hours after sunset. Simultaneously, we monitored the nine radio-tracked little owls to know their position before and during the 30-minute period, thereby following their movements during the experiment. This allowed us to test whether the radio-tagged little owls, if present, responded to the playback recording, and if so, when.

#### Extensive study: effectiveness of call broadcasts to detect little owls

In this case, we ran a large scale presence/absence survey encompassing all the Basque Country area using the knowledge obtained in the previous test and other studies on little owl (Zuberogoitia & Campos, 1997, 1998; Zuberogoitia, 2002; Zabala et al., 2006; Zuberogoitia et al., 2005, 2007, 2008). The area was divided into patches considered ecologically suitable for little owl (open areas) (Zabala et al., 2006). We considered as suitable three different types of area: (1) Coastal countryside: open areas located close to the coast dominated by grass-fields for small cattle farms, urban parks, coastal heather lands, dunes and marshes; (2) Atlantic countryside: orchards and grass-fields for cattle in narrow valleys surrounded by mountains which covered by timber plantations and oak patches; and (3) Mediterranean agricultural areas: dry-farmed and irrigated crops (cereal, potatoes, beetroot and vineyards).

We distributed 300 sample points in 30 areas (10 sample points/area), 80% of them located in areas of good quality for little owls and 20% in low quality areas (open areas surrounded by large forests). We needed some low quality areas to obtain zeros to run the statistics (see MacKenzie et al., 2006). Sample points inside the sample areas should be independent and so the units were at least one km apart. Every sample unit was censused between 2 and 8 times (an average of 5 times per unit, see Meredith, 2008), obtaining a total of 1,500 censuses. Different censuses in the same sample unit were conducted on different days, or in a different location on the same day and at least half an hour after the first census. In this way, the effects and variations caused by sampling site location were included as well as temporal variation. Starting at dusk, we broadcasted little owl calls for 5' and waited another 5' for answers in every sample unit. In this 10' period, we recorded every response and the point of the first detection.

The study was carried out between the 1st of June and the 8th of July 2009, coinciding with the stage in which adults are raising their offspring and when their home range around the nest is minimal, i.e. just in the period in which adults respond to the voices of conspecifics mainly within their core areas (Zuberogoitia et al., 2007; Sunde et al., 2009). Outside this period little owls reduce their territorial behaviour and can be located in communal feeding places, sometimes far from the nesting areas (Zuberogoitia et al., 2007). Spontaneous vocal activity is low during the breeding period (Zuberogoitia et al., 2007) but the little owls detected were mainly breeders, answering close to the nesting sites, and therefore representing true occupation of the areas in question.

To estimate the effectiveness of the method to detect little owls, we analysed results using maximum likelihood estimators (MLE). The results of the survey were considered to be the combination of two unknown probabilities: (a) the probability of the little owl being present at the sample site; and (b) the probability of the species being detected with the method applied. The Presence 2.4. Program (MacKenzie et al., 2006) was used to obtain the MLE of these probabilities from the raw field data. For this analysis we assumed that occupancy of little owl populations in the area to be homogeneous (no strong differences in presence among sub-areas) and that the probability of detection was the same throughout the sampling period (1st June to 8th July 2009). To estimate the effect of repeated sampling we estimated the cumulative probability of detection using the following formula:

$$q_n = (1-p)^n \text{ and } p_n = 1-q_n$$

where  $q$  stands for the probability of going undetected if present,  $p$  for the probability of detection if present and  $n$  the number of times the survey is conducted in the area.

Presence 2.4. was run using the 300 sample units (1,500 surveys) to obtain the occupancy ( $\Psi$ ) and the probability of detection ( $P$ ).

## Results

### Intensive study: changes in owl detection

The radio-tracked owls were located at an average distance of 264.78 m ( $SD = 125.18$ , range = 30–553 m) just before broadcasting the calls. After the broadcast they moved closer to the radio tape from the initial distance, to an average distance of 145.03 m ( $SD = 135.56$ , range = 0–530). Differences between pre- and post-broadcast distances were statistically significant ( $t$ -Student test for matched samples,  $t = 4.991$ ,  $P = 0.000$ ,  $df = 34$ ). There was a positive correlation between the distance at the beginning of the broadcast period and the answer time ( $R^2 = 0.366$ ,  $P = 0.006$ ,  $n = 55$ ).

The average number of detected owls in the 30-minute period was 8.12 ( $SD = 2.47$ ), ranging between 4 and 11 individuals. However, if only the first 5' of playback were considered, the number of detected owls would be 2.25 ( $SD = 1.28$ , range 1–4), and if 10' were considered, the number of detected birds would be 5.37 ( $SD = 2.33$ , range 2–9). Differences were statistically significant among groups (Kruskal–Wallis test,  $H = 18.77$ ,  $P = 0.000$ ). The number of little owls calling in the 30-minute period was similar to the number of little owls detected in the study area (Mann–Whitney test,  $U = 27.5$ ,  $P = 0.645$ ), but the number of little owls calling in the first 10' was significantly lower than the number of owls known to be present in the surroundings (Mann–Whitney test,  $U = 13$ ,  $P = 0.04$ ) and, obviously, the number of detected owls in the first 5' was much lower (Mann–Whitney test,  $U = 1$ ,  $P = 0.001$ ).

The coefficient of variation of the number of little owls detected in the area and calling in the 30-minute period ( $CV = 0.30$ ) increased when the 10-minute period was considered ( $CV = 0.43$ ), and was even higher for the 5-minute period ( $CV = 0.57$ ).

### Extensive study: effectiveness of call broadcasts to detect little owls

Overall, 137 little owl territories were detected in 105 positive sample units (table 1, fig. 1). This suggests an apparent occupation rate of 0.35 (i.e. 35% of the sampled areas was occupied). On the other hand, the software Presence produced a model that estimated occupancy at 0.393 ( $CV 0.052$ ) and probability of detection at 0.439 ( $CV 0.080$ ). Therefore, a single 5-minute broadcast with 5' of subsequent listening would only have detected little owls in approximately half (44%) of the occupied areas. A survey of the study area based on a single broadcast per sample unit would have estimated an occupancy rate of 0.017 (estimated occupancy, 0.393, multiplied by probability of detection with a single sampling occasion, 0.439).

The estimator for the cumulative probability of detection (fig. 2) suggests that in an extensive survey a minimum of four repetitions of censuses in the same sample points in each sample area is required to detect 95% of the areas occupied by little owls.

## Discussion

### Intensive study: changes in owl detection

The results of the censuses varied substantially depending on whether we considered playback and listening periods of 5' or 10'; they would improve, though not by much, if the 10-minute period is considered. The number of little owls detected was close to the real number of territories using the 30-minute periods. However, even in this case, the results were erroneous due to the high mobility of little owls. In this sense, we knew the identity of every little owl tracked and we observed how one owl calling 500 m away could be calling again 2 m close to the broadcast 1' later and fly several hundred meters away a few seconds later.

During the study period, we noted that the home range of little owls varied over the months, being larger during winter, decreasing during the pre-courtship period, and increasing again just after the breeding period (Zuberogoitia et al., 2007). We also detected a high degree of social interactions among paired and unpaired owls. Almost all the tracked little owls shared the same fields during the winter period, and even the unpaired owls and those that had lost clutches used communal fields and foraged in the home ranges of the neighbours. Likewise, we observed that the vocal activity was higher during the courtship period (March and April), decreasing during the breeding season. However, when owls were incubating or hatching owlets they called close to the nests and responded to broadcasts from their breeding home

ranges. Only non-paired owls and those which had failed the incubation approached the playback and produced calls from everywhere.

Had we developed typical censuses of little owl in the area, the results would have been different. Also, by slightly changing the study period, the results would change between years, depending on the number of successful breeding pairs. However, it was impossible to ascertain the real number of territories using a typical playback survey methodology. In such a case, knowledge of the animals' behaviour is needed to interpret the results.

#### Extensive study: effectiveness of call broadcasts to detect little owls

As stated above, although the probability of detection is lower during the breeding period due to the reduction in vocal activity, the positive responses to the playback during this time represent breeding units and not dispersers. Under these circumstances, the detection probability was close to 0.44. This means that, in only one survey, we could hope that more than half of the sample points could be null, even considering that little owls were in the sample points (false negatives). In fact, if we wanted to develop a survey methodology capable of detecting the species with statistical confidence ( $P > 95\%$ ; see fig. 2) we would need at least four censuses in every sampling point to be able to accept or reject the presence of little owls.

The implications of these results, however, are of high practical relevance. The methodological error derived from low intensity surveys (only one visit per site for example) affects estimations of distribution area. This error is usually associated with a low detectability rate and large confidence intervals, most times unknown. Results of such surveys are often used to investigate habitat issues of the species in question, changes in distribution, population trends and other issues. In the case of an annual large scale survey, the inter-annual

Table 1. Number of times each sample unit was surveyed, and percentage of positive sample units and number of points with 100%, 75%, 50% and 25% positive results.

*Tabla 1. Número de ocasiones en las que se censa cada unidad de muestreo y el porcentaje de unidades de muestreo positivas, además del número de puntos con el 100%, 75%, 50% y 25% de los resultados positivos.*

Number of times censused	
2	39
3	103
4	18
5	46
6	37
7	17
8	40
Positive sample units (%)	
100% positive results	4.3
75% positive results	3.3
50% positive results	9.3
25% positive results	12.3

variability due to the changes in the probability of detection could be higher than the real variation in the population trends, and this would lead to erroneous interpretations of the real population trends. Similarly, in habitat studies based on the presence/absence of the target species, according to our results there would

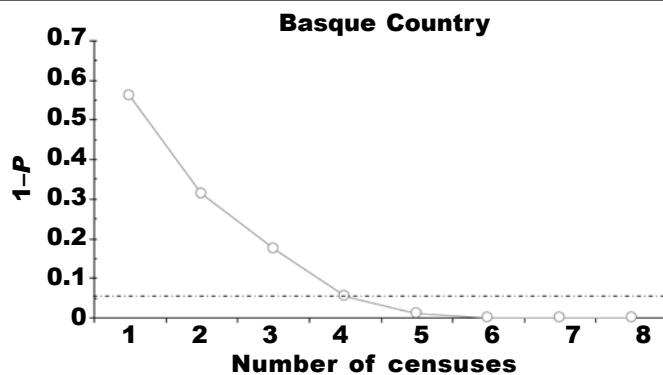


Fig. 2. Probability of false negatives (probability of non-detection knowing the presence) depending on the number of censuses, considering the average value of  $P$ .

*Fig. 2. Probabilidad de falsos negativos (probabilidad de no detección a sabiendas que hay mochuelo) dependiendo del número de censos, considerando el valor medio de  $P$ .*

be more false absences than valid presence points, seriously questioning the validity of the conclusions that could be drawn.

These results should clearly be treated with caution due to the high variability in little owl behaviour in different regions and countries. Nevertheless, they reveal biases associated with broadcasting methodologies, and these could cause serious errors when attempting to ascertain the population dynamics of a given species. We therefore suggest methods should be standardized, beginning with the period of censuses, the minimum length of the monitoring area and number of censuses for large-scale surveys.

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