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Density estimates of passerine bird species in Tenerifean coastal scrub using two different methods (Canary Islands)

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SUMMARY: Attempts to estimate the population density of passerine bird species were made in good and protected areas of Tenerifean coastal scrub using two different methods, (i.e. territory mapping and line transect). Independently of the method used, *Anthus berthelotii* had the highest density, *Sylvia conspicillata* was less abundant and *Lanius meridionalis* was scarce. *Phyllocopus canariensis* and *Serinus canarius* had intermediate values but *Bucanetes githagineus* was so scarce that no density estimate was possible. Line transect overestimated the density estimate for *Anthus berthelotii*. Neither of the two techniques used was perfectly suitable for reliably sampling all passerines in the Tenerifean coastal scrub and therefore it is recommended that future estimates should be made with more precise methods, that allow to measure the error of the estimate and that account for detectability (e.g. Distance sampling).
Key words: passerine birds, density estimates, coastal scrub, Canary Islands, territory mapping, line transect.

RESUMEN: Se estimaron densidades de poblaciones de aves paseriformes en áreas protegidas de matorral costero en Tenerife usando dos métodos diferentes (i.e. mapeo de territorios y transecto lineal). Independientemente del método usado, *Anthus bethelotii* obtuvo la densidad más alta, *Sylvia conspicillata* fue menos abundante y *Lanius meridionalis* fue escaso. *Phylloscopus canariensis* y *Serinus canarius* obtuvo valores intermedios pero *Bucanetes githagineus* fue tan escaso que su densidad no se pudo estimar. El método del transecto lineal sobreestimó la densidad para *Anthus berthelotii*. Ninguna de las dos técnicas usadas fue perfecta para muestrear todas las aves paseriformes en el matorral costero de Tenerife y por consiguiente se recomienda que futuras estimas deberían de realizarse con métodos mas precisos en donde el nivel de

error pueda medirse y en dónde la detectabilidad de las aves se modele (e.g. Distance sampling).
Palabras clave: aves paseriformes, estimas de densidad, matorral costero, islas Canarias, mapeo de territorios, transecto lineal.

INTRODUCTION

Estimating numbers of terrestrial birds has long been a major aspect in ornithology (Ralph & Scott, 1981) and birds are widely recognized as good bio-indicators of the quality of the ecosystems (Gill, 1994). Three methods have been widely used to count birds (i.e. point counts, transect lines and territory mapping; Bibby, 2000) and comparison between these has been made in continental areas (Jolly, 1981).

Tenerife, the main island of the Canarian archipelago, presents five distinctive ecological zones of which the coastal scrub has been widely represented at low altitude (0-500 m a.s.l.) in the past (Ceballos & Ortuño, 1976). Today, it is very scarce in the north and highly degraded and fragmented in the south, mainly due to the rapid development of tourist resorts near the coast (Fernandez-Palacios *et al.*, 2004). This has created "fragmented" patches of uniform habitat within southern Tenerife (pers. obs.), where some are considered as nature reserves (e.g. Malpaís de Rasca, Malpaís de Güimar, Montaña Amarilla) (Martín-Esquivel *et al.*, 1995).

The avifauna of this habitat type, and particularly song birds, is represented by a small number of species (Martin, 1987) and very little is known in quantitative terms (Martín & Lorenzo, 2001). However, the distribution of birds around these areas is fairly well known (e.g. Martin, 1987) and recently some effort has been made to learn more about the birds of the coastal scrub of Tenerife (Carrascal & Palomino, 2005).

On Tenerife, the use of the territory mapping method has only been undertaken at a NE coastal site, where the authors suggested that this method was not efficient for counting birds (Alonso-Quecuty *et al.*, 1990).

The aim of this study was to estimate the density of passerine bird species (by two widely used methods) at the main undisturbed and protected area of coastal scrub of Tenerife (i.e. the Special Nature Reserve of Malpaís de Rasca). Additionally, density estimates of songbird populations (using a popular method), at other important protected areas (i.e. Malpaís de Güimar, Montaña Amarilla) as well as an unprotected area near Abades were attempted. Some recommendations are suggested for future bird monitoring on these areas which are suffering the constant pressure of development.

STUDY AREA AND METHODS

Field work was conducted from late January to early March 2003 in four coastal scrub areas of southern Tenerife (28º20´N-16º20´E) [i.e. Abades (GPS- datum WGS 84 = 358569-3113798, 40 m a.s.l.), Malpaís de Güimar (364876-3131823, 70 m a.s.l.), Montaña Amarilla (338875-3099532, 30 m a.s.l.) & Malpaís de Rasca (332450-3100714, 15 m a.s.l.)]; the latter three are protected areas (see Fig. 1). The climate of this oceanic

island is Mediterranean with cool, wet winters and hot, dry summers (Marzol-Jaén, 1984). The study areas were dominated by *Euphorbia canariensis, Euphorbia balsamifera, Lycium intricatum, Plocama pendula, Launaea arborescens and Schizogyne sericea* (see Ceballos & Ortuño 1976 for a detail description of this habitat type). Small patches of abandoned cultivated fields were sparsely present on some of these sites where herbaceous and succulent plants were present (e.g *Patellifolia* sp. and *Mesembryanthemum* sp.).

Two different bird census techniques were employed on this study: Line transects (LT) and territory mapping (TM) (Bibby *et al.*, 2000). Line transects are best suited for large areas that are relatively uniform and are probably more accurate than point counts (Bibby *et al.*, 2000) while territory mapping is an especially suitable method for conducting a census of species that show conspicuous territorial behaviour within relatively small territories (Verner, 1985). These methods generally assume that all birds present are detected and hence density estimates must be considered as minimum.

A total of 24.3 km was sampled by linear transects on 26 January (site 1; 6.5 km), 2 February (site 2; 6.7 km), 16 February (site 3; 5.9 km) & 5 March (site 4; 5.2 km). Distances to the birds were estimated by eye within a main belt of 25 m on both sides of the observer (i.e. 0-25) and two supplementary belts of 25-50 & 50-100. However, only the contacts within the main belt were used to calculate density. Speed of walking was 1-3 km/h.

A 68 ha plot was selected at Rasca for territory mapping (i.e. Las Arenitas, GPS, datum WGS 84 = 332450-3100714) (Fig. 1). To ensure accuracy in mapping birds a 25 m grid was spread over the study site by using colour tape on the vegetation. Eight visits were made at weekly intervals (i.e. 3, 11, 18, 25 January, 1, 8, 15, 22 February). The plot was walked at a slow pace, the route and directions varied between visits and data from the eight visits were used to estimate numbers of breeding territories. A considerable amount of nest searching was undertaken. This generated additional information which was taken into account when interpreting the results of the territory mapping.

To minimize measurement errors during field work no counts or mapping were made on mornings with strong wind or rain. Line transect data were analysed using methods described by Järvinen & Väisänen (1975), while the number of territories were estimated as described by Bibby *et al.* (2000). All statistical analyses (i.e. Chi-square tests) were performed using SPSS v. 11 and Zar (1984). Data are presented as birds/10ha.

RESULTS

Two bird species dominated the Tenerifean coastal scrub in distribution and in abundance (i.e. found at all sites, *Anthus berthelotii* showed the highest density and *Sylvia conspicillata* the second highest) (Chi-square test, D1: $\chi^2_2 = 10.32$, $P<0.01$; D2: $\chi^2_4 = 113.39$, $P<0.0001$; D3: $\chi^2_2 = 7.18$, $P<0.05$) (see Table I). *Lanius meridionalis* was only recorded at site 4 (Fig 1) in very low numbers. *Phylloscopus canariensis* was only encountered at site 1 & 2 and *Serinus canarius* at site 1. Both in similar numbers (Chi-square test, $\chi^2_2 = 0.33$, $P>0.05$). *Bucanetes githagineus* was recorded as a visitor

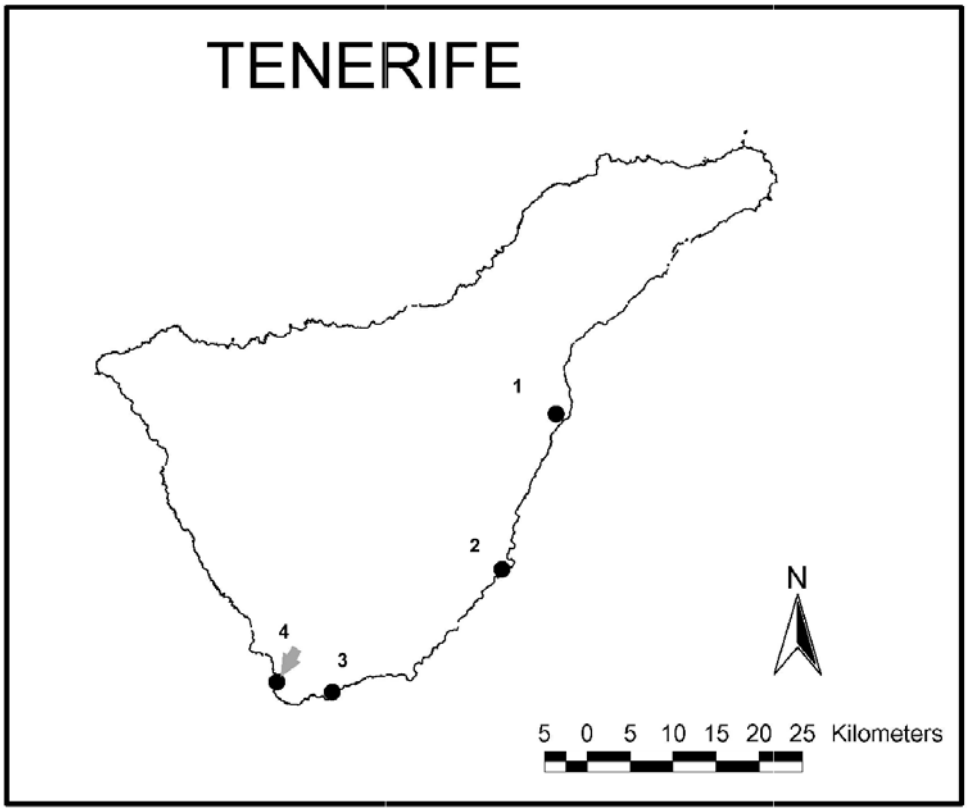

Figure 1. Distribution of areas sampled in this study (dots) (1= Malpaís de Güimar, 2= Abades, 3= Montaña Amarilla, 4= Malpaís de Rasca) and the study plot for territory mapping within site 4 (arrow).

to the territory mapping plot (site 4) and was also contacted once at site 2, not allowing density to be derived from the small number of encounters.

Assuming that detectability was the same at all sites, inter-sites statistically significant differences were found for *Anthus berthelotii* (Chi-square test: $\chi^2_3 = 9.85$, $P<0.05$) (i.e.highest abundance at site 1), but not for *Sylvia conspicillata* ($\chi^2_3 = 0.38$, $P>0.05$) or *Phylloscopus canariensis* ($\chi^2_1 = 1.67$, $P>0.05$). No comparison was possible for *Lanius meridionalis*, *Serinus canarius* and *Bucanetes githagineus*.

Generally, differences between the methods (frequency of singing males) were statistically significant for *Anthus berthelotii* (Chi-square test, $\chi^2_1 = 18.00$, $P<0.0001$) but not for *Sylvia conspicillata* ($\chi^2_1 = 3.50$, $P>0.05$) and *Lanius meridionalis* ($\chi^2_1 = 0.1$, $P>0.05$). Within site 4, the same was observed: *Anthus berthelotii* (Chi-square test, $\chi^2_1 = 13.09$, $P<0.0001$), *Sylvia conspicillata* ($\chi^2_1 = 3.52$, $P>0.05$) and *Lanius meridionalis* ($\chi^2_1 = 3.60$, $P>0.05$) (Table I). Hence, line transect overestimates density for *Anthus berthelotii* when compared to territory mapping because the effort undertaken in the latter is much greater than the former (i.e. consequently more precise).

Table I. Density (birds/10ha, TM= density by territory mapping, LT= mean total density by line transect, LT4= density by line transect at site 4) for every bird species (A= *Anthus berthelotii*, SC= *Sylvia conspicillata*, L= *Lanius meridionalis*, S= *Serinus canarius*, P= *Phylloscopus canariensis*). Date when the census was undertaken also included (0 = no encounters).

	A	SC	L	S	P	Date
TM	2.94	2.06	0.59	0	0	Jan-Feb
LT (overall)	6.82	4.77	0.27	1.25	1.53	26 Jan-5 March
LT4	5.45	2.60	1.31	0	0	5 March

DISCUSSION

Comparison with other studies

Assuming that territory mapping provides a more precise density estimate than line transect (Bibby *et al.*, 2000; Ralph & Scott, 1981), this study suggest that *Anthus berthelotii* is the dominant passerine bird species in Tenerifean coastal scrub. It was found at higher densities at the Special Nature Reserve of Malpaís de Güimar (i.e. 2.94 birds/10 ha, territory mapping). Carrascal & Palomino (2005) suggest that the abundance of *Anthus berthelotii* increases due to the herbaceous layer increases. Thus, the inter-sites differences found on this study might be related to optimal areas versus poorer areas.

For "dry scrubland of several *Euphorbia* species" (see Carrascal & Palomino, *op. cit.*) in southern Tenerife the minimum density estimate for *Anthus berthelotii* (by line transect) is similar to the one I present for site 4 (i.e. 5.47 birds/10ha, see Table I) but their overall southern density estimate (for all sites below 500 m a.s.l.) is smaller (5.48 vs 6.82 birds/10ha). In any case, and assuming that line transect overestimates density for *Anthus berthelotii* (this study), all these estimates should be taken with some care.

Sylvia conspicillata showed the second highest density in Tenerifean coastal scrub (2.06 birds/10ha, territory mapping) and inter-sites differences were not observed on this study. Overall (for all sites below 500 m a.s.l.), Carrascal & Palomino (2005) provide an extremely low value (i.e. 0.46 birds/10ha) which contradicts with the results of this study (see Table I). For other similar areas, these authors also provide very small density estimates (i.e. 0.60, 0.42, 0.62 birds/10ha). These results can easily be explained by differences in the census timing (April vs Jan-Feb in this study). Early breeding on Tenerife is common (Ennion & Ennion, 1962) and in Tenerifean coastal scrub most passerines lay eggs in February but some individuals do lay as early as January (E. Garcia-del-Rey unpublished data) or even December (Martín & Lorenzo, 2001). Particularly for *Sylvia conspicillata*, their flight song display becomes less obvious as the season progresses (pers. obs.). However, a similar value is presented by Carrascal & Palomino (2005) for the "mosaic of agricultural fields devoted to several crops" in the south of Tenerife (i.e. 2.18 birds/10 ha) but this vegetation formation is at 728 m in altitude, way above the altitude sampled in this study (maximum altitude at 70 m a.s.l.)..

For other more restricted passerines (e.g. *Serinus canarius* and *Phylloscopus canariensis*), density estimates when compared to Carrascal & Palomino (2005) values

(below 500 m a.s.l.) were similar for *Serinus canarius* (1.00 vs 1.25 birds/10ha) and *Phylloscopus canariensis* (2.61 vs 1.53 birds/10ha). Carrascal & Palomino (*op. cit.*) density estimate for *Lanius meridionalis* was similar to the one obtained by territory mapping on this study (i.e. 0.69 birds/10 ha vs 0.59 this study) but the number of contacts and precision of estimates were not provided for a scarce bird like this. The actual total population of *Bucanetes githagineus* on Tenerife is so small (*c.* 40-50 birds, pers. obs.) that deriving reliable density estimates was not possible in this study (0.31 birds/10ha by Carrascal & Palomino, 2005).

Neither of the two census techniques was perfectly suitable to reliably sample all passerines in the Tenerifean coastal scrub. In any case, these methods are different in principle, because using territory mapping only resident birds are counted during most of the breeding season, whereas in transect counts all birds observed and heard are recorded in a single visit (Svensson, 1981). Svensson (*op. cit*) also found different results by these two methods on the Lapland study carried out in the same small area of homogeneous habitat. My results disagree with what other authors have emphasised about the territory mapping technique on Tenerife in the past (Alonso-Quecuty *et al.*, 1990) because this method was perfectly suitable to record simultaneous singing males (i.e. counter singing), at least in Tenerifean coastal scrub.

Therefore, there is a need for density to be estimated with more precise methods, those that account for detectability and error measurements (i.e. confident intervals). Existing estimates in the Canaries (all based on Bibby *et al.*, 2000) have tended to rely on the assumption that all, or most, of the birds present were detected, and provide no indication of the level of statistical confidence associated with each estimate. Distance sampling has emerged as an efficient, reliable approach to abundance estimation (Buckland *et al.*, 2001) and its use is highly recommended for future passerine bird monitoring in Tenerife.

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