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POPULATION ESTIMATES: TOWARDS STANDARDISED PROTOCOLS AS A BASIS FOR COMPARABILITY

ESTIMAS POBLACIONALES: HACIA PROTOCOLOS ESTANDARIZADOS COMO BASE PARA SU COMPARACIÓN

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SUMMARY.—Population estimates are an essential demographic parameter for assessing the threat status of species and the international significance of national populations. Murgui (2011) provides the most up-to-date review of the bird population estimates produced in Spain over past decades and he describes their methodological limitations, particularly those derived from data availability, sampling bias and analytical shortcomings. Two of the main procedures associated with the generation of reliable population estimates, the calculation of densities and their extrapolation over whole-species ranges are discussed here with the aim of contributing to improving comparability between estimates. In this connection, we present some new approaches developed in the Catalan Winter Bird Atlas 2006-2009, such as the stratification of density estimates using habitat suitability indices derived from species distribution modelling, and the consideration of detectability not only for common species but also for scarcer ones. Finally, applications of population estimates are discussed and we call for Europe-wide collaboration to enable between-country comparability of such estimates to be improved.

Key words: detectability, distribution modelling, international perspective, population sizes, practical use.

RESUMEN.—Las estimas poblacionales son un parámetro crucial para evaluar el estatus de amenaza de las especies y la responsabilidad que sobre ellas se tiene a nivel internacional. El estudio realizado por Murgui (2011) ofrece la revisión más actualizada sobre las distintas estimaciones del tamaño poblacional de las aves realizadas en España en las últimas décadas y describe sus limitaciones metodológicas, en particular las derivadas de la disponibilidad de datos, los sesgos de muestreo y las deficiencias analíticas. Con el objetivo de contribuir a la mejora de las comparaciones entre las estimaciones, en este artículo se analizan dos de los principales procedimientos asociados a la generación de las estimaciones poblacionales fiables, el cálculo de densidades y su proyección en todo el rango de distribución de la especie. En este contexto, se presentan algunos de los nuevos enfoques llevados a cabo en Atlas de las Aves de Invierno en Cataluña 2006-2009, como la estratificación de las estimaciones de la densidad

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a partir de los índices de adecuación del hábitat obtenidos a partir de modelización de la distribución de la especie, o la consideración de la detectabilidad no sólo en especies comunes, sino también en especies más escasas. Por último, se discuten las aplicaciones de las estimaciones poblacionales y se hace una llamada a la colaboración a escala europea como elemento fundamental para poder mejorar las comparaciones de éstas entre distintos países.

Palabras clave: detectabilidad, modelización de la distribución, perspectiva internacional, tamaños poblacionales, uso práctico.

Introduction

Population estimates are essential for bird conservation. Parameters such as threat status at global, national or regional levels, or the contribution in terms of conservation efforts that different countries or regions should invest, require adequate species population estimates (IUCN, 2004; Keller and Bollmann, 2004). The study by Murgui (2011) stands as a timely revision of the information on bird population estimates currently available for Spain. Differences between estimates were noticeable for many species and the author suggests that this is probably related to limitations in data availability, biases in (or even absence of) sampling design, and the use of different analytical methods to estimate population density. The author suggests priorities for obtaining better approaches and agreeing population estimate methodologies both within Spain and between European countries.

Principal factors to consider

The study by Murgui (2011) determines that relative population estimates derived by different methods agree to a large extent in ranking relative abundances between species. This is an informative result indicating that different methods are able to reveal interspecific differences in population size, a property that has been previously described in other cross-methodological comparisons (Newson *et al.*, 2008). The only exception to this seems to be the cases of urban species, which show larger differences between population estimates when compared with other species groups, probably because urban habitats were poorly monitored in earlier studies in Spain, as also reported for the United Kingdom (Newson *et al.*, 2008). However, in general, differences in population estimates between methods are consistent and led for instance to SACRE estimates being five to ten times higher than other estimates. Such consistent differences suggest that the art of estimating bird population sizes is subject to major problems associated with the methodology employed.

In addition to the biases related to field sampling methods and data quality, discussed in detail by Murgui (2011) –and see also Frederick *et al.* (2003) and Quesada *et al.*, (2010)– population estimates are especially reliant upon two main methodological issues also mentioned in his review: the correct estimation of densities and their adequate extrapolation to whole-species distributions.

Density estimation

The existence of consistent differences between the methods reported by Murgui (2011) suggests that intrinsic methodological biases probably underlie different density estimation procedures. Methods that attempt to correct for detectability tend to include more individuals in final estimates than those that rely solely on the observed data (Kéry, 2008). Actual densities thus probably lie somewhere between the number of individuals observed in the field and the corrected value that includes an estimate of non-detected individuals. Consistent inaccuracies in the latter will lead to larger or smaller estimates for all species, to a variable extent associated with species' detectability. For instance, minor differences in the effective area sampled by a field method, or different assumptions on detectability, may lead to major, consistent changes in density estimates and thus in population estimates (Buckland *et al.*, 2004). It is therefore critical to correct for detectability with caution, taking into account the quantitative and qualitative limitations of the data obtained in the field. Ideally, the procedures used to estimate densities should be adjusted by comparing their outcomes with independently acquired, accurate density data. For example, territory mapping could be a valuable source of such data in some areas and for some species. Such adjustments could form part of a standard procedure aimed at identifying the principal methodological biases and correcting to obtain more accurate population estimates. We advocate the adoption of accepted, validated methods that take detectability into account: such as distance sampling (Buckland *et al.*, 2004) or capture-recapture procedures (Kéry *et al.*, 2005), and the development of standardised protocols in order to reduce or eliminate biases in density estimates obtained by different approaches.

Extrapolation of density estimates

The extrapolation of estimated densities per habitat to the whole study area has commonly been used to assess population sizes. However, imprecision in determining densities within a given habitat may produce species-specific biases in final population estimates. Murgui (2011) and Newson *et al.* (2008) offer examples for urban habitats. In addition, biases may be also relatively large in extrapolations applied to species for which variations in abundance across the range are associated with factors other than habitats. This may be especially relevant in population estimates generated for large areas where there are marked environmental gradients, such as within Spain. In these cases, alternative extrapolation methodologies, using density zoning derived from environmental gradients other than habitat, could be applied in the protocol of population estimate assessment (Herrando *et al.*, 2008). As with density estimation approaches, we advocate common, agreed (and published) protocols for density extrapolation to large regions.

Possible ways forward

As indicated by Murgui (2011), the assessment of breeding bird population sizes in Spain has greatly improved in recent times. However, we think the way forward should take into account the opportunities and limitations of the two major issues described here and should make the best possible use of available information while minimising the need to collect further or complementary data. Common bird monitoring data can provide a valuable basis for calculating densities and extrapolating them to an entire study area in order to obtain population estimates. However, deciding when there is enough high quality data on a given species to warrant the application of such techniques as distance sampling is not straightforward. A conservative approach is advisable to avoid assessments that have a high probability of biasing population estimates. This argues in favour of employing alternative methods for scarcer species and common species that will address key issues such as detectability adequately. We exemplify this by summarising the approach taken in the recent Catalan Winter Bird Atlas (Herrando *et al.*, 2011), in which population estimates of winter populations were addressed.

As commented by Murgui (2011), new schemes for obtaining population estimates may be based on existing monitoring programmes, extended to cover a particular period. This is exactly the approach underlying the population estimates published in the Catalan atlas, which was based on the existing SOCC monitoring scheme, employing about 300 3-km line transects extended by a further *c.* 200 3-km transects to enable unbiased sampling for many species (Herrando *et al.*, 2011). Density estimates for common birds were obtained by a distance sampling procedure (Buckland *et al.*, 2004). As a novel approach, density estimates and the extrapolation process were not based on a particular habitat classification but were derived from a habitat suitability index map previously generated by MAXENT distribution models for the whole study area. This procedure incorporated the niche-based variance associated with over 80 variables (habitat, climate, relief, human influence, etc.) and also measures of spatial autocorrelation in species presence. We consider that this allowed more precise stratifications of densities than those obtained directly using habitat classifications (e. g., vegetation types). Furthermore, this approach also enables the use of relevant data for different purposes since deriving habitat suitability index maps requires only presence data, thus allowing a better match between available data and the specific objective (i.e. spatial stratification vs. density estimation). Nevertheless, this analytical approach was not possible for many scarce species for which the assumptions of distance sampling procedures were violated. For such species we also had to rely on the rough estimates provided by field workers for each 10 × 10 km square sampled. However, despite the totally different nature of the data and the subsequent analyses, we also took into account detection probabilities by considering that the species occurred in squares in which they were not detected but where the species' distribution models indicated high habitat suitability.

Comparing and using estimates

The existence of population estimates that differ in magnitude is a source of potential confusion and potentially damages their credibility in the wider public domain (Newson *et al.*, 2008), ultimately affecting their utility for conservation and management purposes. For instance, if the latest population estimates in Spain were accurate, then the current estimates of European populations (BirdLife International, 2004) would be too conservative, which in turn could affect the assessment of conservation status of many species. This takes us to the essential point in our discussion on the utility of population estimates and the effects of their accuracy: what are they used for?

As Murgui (2011) shows, employing population estimates from different periods of time in order to determine temporal trends should be discouraged since the conclusions may be greatly affected by the differences between the methods employed on different occasions. On the other hand, their potential application for testing ecological hypothesis (habitat selection, etc.) seems highly hampered by the coarse spatial resolution (e. g., region, country) at which they are generated. One of the main purposes of population estimates is to provide information on the variability in relative abundance of the species occurring in a given area and, in general, this has already been achieved in Spain since the first population estimates were made (Murgui, 2011). However, although such information may provide guidelines for conservation priorities, accurate threat status assessments should always incorporate information on population sizes from other areas in which the species is also present (Gärdenfors *et al.*, 2001). Population estimates for a given area should be compared to those for neighbouring ones, not only to evaluate extinction risks (sink-source demographic relations) but also to assess the importance of that area relative to the wider species' distribution. However, a great deal of caution is required where comparisons between countries or regions are based on population estimates derived from different methods. In a European context, deciding whether a country accounts for a sufficiently large proportion of a species' population to warrant the focusing of conservation efforts there is currently considerably hampered by the absence of standardised protocols and comparable population estimates. Despite the huge limitations of working on a continental scale, we are confronting a key question that should promote truly collaborative work in the near future. This collaborative work should aim at providing the references and standardised protocols suggested by Murgui (2011) and at developing common strategies for population estimation that make the best possible use of available data, complemented by new data on those species for which standard monitoring methods perform poorly. We hope that such continent-wide initiatives as the second EBCC European Breeding Bird Atlas will provide new avenues for progress towards obtaining comparable population estimates.

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