Determining population trends and conservation status of the common quail (*Coturnix coturnix*) in Western Europe

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Abstract

*Determining population trends and conservation status of the common quail (*Coturnix coturnix*) in Western Europe.*— In this paper we review the conservation status and population trends of the common quail (*Coturnix coturnix*) from 1900 to the present. Data are sometimes contradictory with regard to the status of this species as it has some features that make it difficult to produce reliable population estimates. Recent data clearly suggest, either at a local scale or at a trans–national scale, that the Atlantic common quail populations have remained stable in the last two decades, and that restocking practices with farm–reared quails (hybrids with the Japanese quail, *Coturnix japonica*) do not affect our estimates. The complex movement patterns showed by this species require special attention. Analysis of ring recoveries can give important information, especially about the nomadic movement of quails in search of suitable habitats after the destruction of winter cereal crops due to harvesting. Thus, when developing a breeding distribution model for this species, continuously updated information on seasonal habitat and weather must be included for optimal prediction. Including fortnightly data of vegetation indices in distribution models, for example, has shown good results. Obtaining reliable predictions about changes in species distribution and movements during the breeding period could provide useful knowledge about the conservation status and population trends and would help in the design of future management measures.

Key words: Conservation status, Population trends, Hybrids, Nomadic movements, Management.

Resumen

*Determinación de las tendencias poblacionales y el estado de conservación de la codorniz común (*Coturnix coturnix*) en Europa Occidental.*— En el presente estudio hacemos una revisión del estado de conservación y las tendencias poblacionales de la codorniz común (*Coturnix coturnix*) desde 1900 hasta nuestros días. Algunos de los datos de los que disponemos son contradictorios con respecto al estado de la especie, que presenta ciertas características que dificultan el poder proporcionar estimas poblacionales fiables. Datos recientes sugieren claramente, tanto a escala local como a escala transnacional, que las poblaciones atlánticas de codorniz común han permanecido estables en las dos últimas décadas y que la práctica de liberar codornices criadas en granjas (híbridas con la codorniz japonesa, *Coturnix japonica*) con finalidades cinegéticas, no afectan significativamente a nuestras estimas. Por otra parte, los complejos patrones de desplazamiento de esta especie requieren especial atención. En este sentido, el análisis de recuperaciones de anillas puede aportar información relevante, especialmente de los movimientos nomádicos de codornices a la búsqueda de hábitats adecuados, tras la destrucción de los cultivos invernales de cereales debido a la siega. Así, al desarrollar un modelo de distribución de cría para esta especie, se debe incorporar continuamente información actualizada de los cambios estacionales de hábitat y clima, con el fin de obtener unas predicciones óptimas. En este sentido, por ejemplo, la inclusión de datos quincenales de índices de vegetación en los modelos de distribución ha dado muy buenos resultados. La obtención de predicciones fiables de los cambios de la distribución de la especie y de sus desplazamientos durante la estación de cría puede ser muy útil para un mejor conocimiento del estado de conservación y las tendencias poblacionales de la especie, así como para el diseño de futuras medidas de gestión.

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Historical review of the conservation status of the common quail

It is generally accepted by the scientific community that to develop suitable management and conservation policies it is necessary to have an exhaustive knowledge of the life history of the species we seek to preserve and to provide reliable population estimates (IUCN, 2001; Perennou, 2009). However, such estimates are not yet clear for the common quail, a relatively protected (Bern Convention of 1979) huntable species (Birds Directive 2009/147/EC) with an unfavourable conservation state (Bonn Convention of 1983).

If we analyse the changes in conservation status over time, we can define three different stages:

(1) The period from 1900 to the 1970s. Not surprisingly, during this period the status of the species remains unclear, mainly because of a lack of reliable data. However, it is accepted that a marked decrease occurred in the first half of the century in the Atlantic populations (Moreau, 1951). This is supported by a long series of data (1900–1959) in Luxembourg which suggests a dramatic decrease in quail abundance, starting at the beginning of the 20th century and finishing in the 1930s; however, a partial recovery was observed from 1947 to 1950. Later, another decreasing trend was observed (Davies et al., 1966). Moreover, in France, data collected by one hunter from 1965 to 1988 in the Lauragais region showed a decrease, especially from 1970 to 1977 (Combreau, 1992). Saint–Jalme & Guyomarc'h (1989) suggested there was a progressive reduction of wintering individuals in the Sahel after 1950, coinciding with the development of irrigated perimeters in the Maghreb, thus entailing a reduction of long–migrant phenotypes which would arrive in Europe. However, there is some evidence indicating that perhaps this decreasing trend was not so clear; in the 1940s, an increase in the number of quails was observed in some European countries, such as Germany, United Kingdom and the Scandinavian countries. Moreover, the spring passage of quails at Cape Bon (Tunisia) from 1953 to 1966 did not show a decrease (Derégnaucourt, 2000).

(2) The period from 1970 to 1990. According to Birdlife International (see Burfield, 2004), in this period quail populations declined in many countries of central and northern Europe, leading to an unfavourable conservation status; populations were thus vulnerable and in large decline (Tucker & Heath, 1994). This decrease is statistically significant (Sanderson et al., 2006), but as suggested by Perennou (2009), the quantitative amplitude of the decline is unknown due to the lack of reliable pan–European estimates or indices.

(3) The period from 1990 to 2000. Birdlife International (see Burfield, 2004) suggests that common quail populations were depleted due to a large historical decrease, leading to an unfavourable population status in Europe. When compared to the previous period (1970–1990), some increases were observed in northern and central Europe, whereas some declines were observed in south–eastern Europe. However, a global significant decrease was not observed (Sanderson et al., 2006). Indeed, when we restrict the distribution area to the European Union of the 25 state members, population trends remain stable, the threat status of the species is secure, and its conservation status is favourable (Birdlife International, 2004). These data are surprising bearing in mind that most long–distance migrants are currently declining alarmingly (Birdlife International, 2004) and farmland birds are in steep decline (Gregory et al., 2005). The common quail has the double category of being both a migratory species and a farmland bird, so it constitutes an exception to these general trends.

Over the last decades, other data fail to clarify the situation because of further contradictory results (Puigcerver et al., 2004). For example, the French 'Office National de la Chasse et de la Faune Sauvage' carried out national hunting surveys in 1983 (Ferrand, 1986) and in 1988. According to the data obtained, a decrease of 50% was observed when comparing these two sampling years. In Spain, a monitoring programme of the most common bird species ('SACRE' Programme) showed a decrease in the 1998–2006 period, with an annual evolution of –6.8% (Carrascal & Palomino, 2008); from 1998 to 2010, the percentage of change reached –38% (Escandell et al., 2011). In agreement with this information, when comparing the data of the first Catalan breeding birds atlas, encompassing the period 1975–1983 (Muntaner et al., 1983) with data from the second atlas covering the period 1999–2002 (Estrada et al., 2004), a decrease of 27% in species distribution is found. On the other hand, no significanct trend was observed for quails hunted in Spain during the period 1976–2008 (Rodríguez–Teijeiro et al., 2009; *Yearbook of Agro–alimentary Statistics* of the Spanish Ministry of Agriculture, Fishing and Food). Furthermore, at a local scale, a long unpublished data series of common quails hunted under a constant effort in Torres de Alcanadre (Huesca Province, Spain) during 1992–2010 showed a significant increasing trend. It is also of note that no significant trends were observed in a study carried out in two Catalan breeding sites throughout the breeding seasons from 1988 to 2011 (see 'Advances towards more reliable estimates. Common quail monitoring' section).

The reliability of common quail population estimates

These contradictory data show that it is not easy to provide reliable estimates of common quail populations. Gregory et al. (2005) do not provide population indexes of the common quail in their study concerning the trends of farmland birds in Europe, stating that it is 'highly volatile in numbers and has an erratic migrant breeding population'. In spite of the effort carried out by Guyomarc'h (1992) to describe and to understand the structure, working and micro–evolution of the common quail populations of the Western Palearctic, it is not easy to provide reliable estimates of this species for several reasons:

(1) It is (or it was) usual practice in European countries where the common quail is a popular game species to restock with farm–reared quails, which were often hybrids of common quail (*Coturnix coturnix*) and Japanese

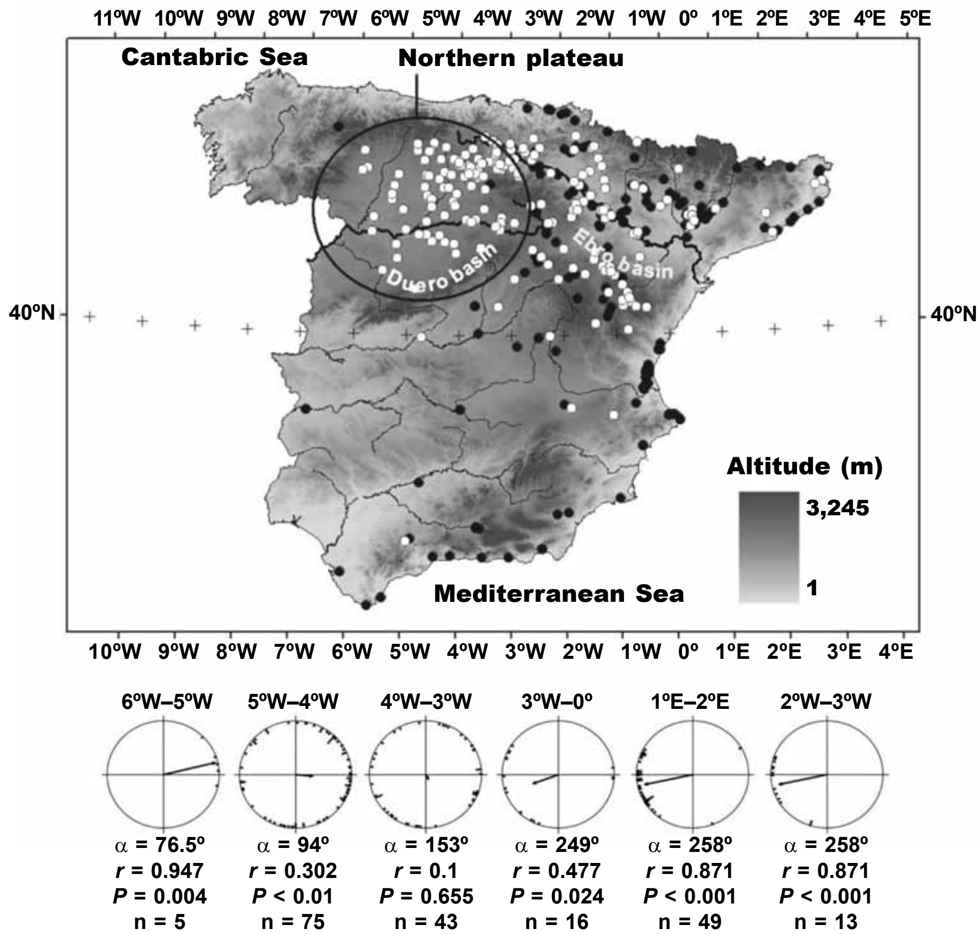

Fig. 1. Recoveries of Spanish ringed individuals (white dots in the map and triangles in the circular diagrams) and preferred directions, grouped in sectors of geographical longitudes within an axis east (3º)–west (–9º). Rayleigh test statistics are shown: n. Sample size; α. Mean angle of the distribution; r. Rayleigh test statistic; and p. Significant value of the test. (Black dots are ring recoveries of quails ringed in other European countries from Rodríguez–Teijeiro et al., 2009.)

Fig. 1. Recuperación de individuos hispánicos anillados (con puntos en el mapa y triángulos en los diagramas circulares) y direcciones preferidas, agrupadas en sectores de longitudes geográficas dentro de un eje este (3º)–oeste (–9º). Se presentan los parámetros del test de Rayleigh: n. Tamaño de la muestra; α. Ángulo medio de distribución; r. Estadístico del test de Rayleigh; p. Valor significativo del test. (Los puntos negros representan las recuperaciones de codornices anilladas en otros países europeos de Rodríguez–Teijeiro et al., 2009.)

quail (*Coturnix japonica*) (Amaral et al., 2007; Barilani et al., 2005; Chazara et al., 2006; Sanchez–Donoso et al., 2012). These practices are currently forbidden in most European countries (2002 in France and Portugal, 2007 in Spain, for example) but they might constitute a distortion factor when trying to census native common quail populations due to the large number of restocked individuals and to the difficulties of distinguishing common quails and farm–reared hybrids from their phenotypes; thus, in Catalonia (NE Spain), male common quail populations have been estimated between 5,374 and 20,847 individuals (Estrada et al., 2004), and during the period 1990–2006, a total of 1,161,113 farm–reared quails were restocked (65,295 individuals restocked per year, see Puigcerver et al., 2007).

(2) The common quail is extremely mobile. It is not only a partial migrant species, with long–migrant and short–migrant phenotypes, together with sedentary ones (Belhamra, 1997; Guyomarc'h & Belhamra, 1998; Saint–Jalme 1990; Saint–Jalme et al., 1988), but also a nomadic species, in search of suitable but ephemeral habitats which mainly comprise cereal crops, such as wheat and barley. The ripening of these cereal crops varies in latitude and in altitude, so habitats placed at lower latitudes and altitudes are destroyed (due to harvesting) earlier than those located in higher latitudes and

altitudes. The result is that quails match their biological cycle to those of cereal crops, and their movements fit the temporal and spatial variations which constantly and predictably affect the cereal crops (Puigcerver et al., 1989; Rodríguez–Teijeiro et al., 2009). Thus, the analyse of recoveries of common quail individuals ringed in Spain showed that the timing of harvesting, combined with geographical relief, can act as a funnel forcing quail populations to concentrate with pre–migratory dispersive movements in certain areas (Rodríguez–Teijeiro et al., 2009; fig. 1; see 'ringing recoveries section'). There is another type of movement, carried out by unpaired males in search of females, which has been described as the 'Don Juan movement' (Rodríguez–Teijeiro et al., 2006); generally, these are movements of 50 km or more (own unpublished data). These three movements cause a constant inflow and outflow of males in the breeding areas throughout the breeding season, resulting in a turnover ratio of almost 95% in less than 15 days (Rodríguez–Teijeiro et al., 1992). As a consequence, it is usual to capture four times more individuals than those daily censused during the breeding season (Rodríguez–Teijeiro et al., 1992) despite using a capture method which has an effectiveness of 50% (Gallego et al., 1993).

(3) Last but not least, we should not forget that the breeding cycle of the common quail occurs inside dense cereal crops and goes unnoticed; unpaired males can be acoustically detected, but females and breeding pairs remain visually and acoustically invisible to the observer (Guyomarc'h, 2003).

Advances towards more reliable estimates. Common quail monitoring

To address this complicated situation, a specific census methodology has recently been proposed for the common quail (Rodríguez–Teijeiro et al., 2010). This method entails continuous monitoring from year to year based on the census and capture of calling males throughout the breeding season (once a week in ten count points, following Bibby et al., 2000), which provides reliable information on density and phenology. This method is more efficient (more individuals are detected) than that provided by Guyomarc'h et al. (1998), which does not involve capture. As the harvesting period occurs when broods remain with the female in most breeding areas, monitoring carried out during harvest is also a useful methodology. It allows the number of females that have bred in the sampled areas to be censused, and the size and approximate age of broods to be known. Monitoring hunting bags may also provide useful and complementary information on the sex and age proportions of common quail populations during hunting periods.

This methodology was applied at a local scale in two breeding sites in Catalonia, Northeast Spain (Figuerola del Camp and Alp), from 1988 to 2011, and at a trans–national scale in 10 different breeding sites in four countries (Morocco, Portugal, Spain and France) considered central to the Atlantic population (Gallego et al., 1997), from 2005 to 2009 (fig. 2).

Fig. 2. Breeding sites in Morocco, Portugal, France and Spain where the common quail was monitored using the method of Rodríguez–Teijeiro et al. (2010).

Fig. 2. Lugares de cría en Marruecos, Portugal, Francia y España, en los que la codorniz común se monitorizó mediante el método de Rodríguez–Teijeiro et al. (2010).

With regard to the census in Catalonia, the abundance index (annual average number of quails censused per day sampled at weekly intervals throughout the breeding season) clearly shows that common quail populations have marked interannual fluctuations, but there was no significant trend in either of the two populations sampled over the last 24 years (fig. 3).

At a trans–national scale, when globally analysing the 10 breeding sites of the four countries of the Atlantic population from 2005 to 2009, no significant trends were observed in the average modal number of male quails detected during the breeding seasons (as a surrogate of an abundance index), either in the breeding sites or in the countries analysed (Rodríguez–Teijeiro et al., 2010; fig. 4). This modal value ranged from two individuals in 2005 in Figuerola del Camp (Spain) to 130 in 2006 in Fki–Ben–Salah (Morocco).

Thus, the results from local data, supported by the results from the trans–national study, suggest that the

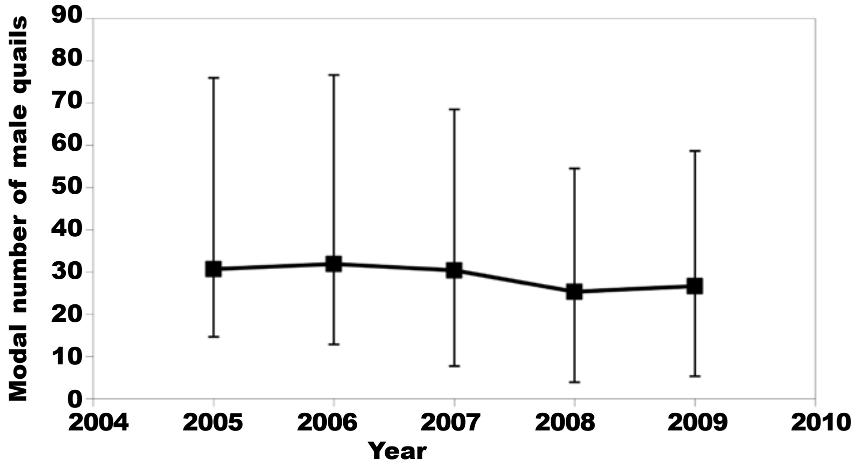

Fig. 3. Annual average of the modal number of male quails (± SE) censused in the breeding seasons of 2005–2009 at the breeding sites reported in fig. 2.

Fig. 3. Promedio anual del número modal de codornices macho (± EE) censadas en las estaciones de cría de 2005–2009 en los lugares de cría incluidos en la fig. 2.

Atlantic common quail populations remain stable, as suggested by Fontoura & Gonçalves (1998) and Burfield (2004). This is contrary to the data presented by Ferrand (1986) in conjunction with the data of the French national hunting survey of 1998, and to findings by Muntaner et al. (1983), Estrada et al. (2004), Carrascal & Palomino (2008) and Escandell et al. (2011).

Detection of hybrids

As the turnover ratio of males is around 95% in less than 15 days (Rodríguez–Teijeiro et al., 1992) in northeast Spain, it is necessary not only to census individuals, but also to capture and ring them. A common method to capture quails during the breeding season consists in attracting males towards a net horizontally extended over a cereal crop, with the aid of an electronic female decoy, forcing individuals approaching it to fly and thus trapping them in the net.

This capture method ensures an effectiveness of 50% (Gallego et al., 1993); its application allows us to detect hybrid males by the differences in their call structure (Collins & Goldsmith, 1998), as learning has no influence on the development of vocalisations (Konishni & Nottebom, 1969; Baptista, 1996), which are very stereotyped in the male common quail (Schleidt & Shalter, 1973). However, this method underestimates the proportion of hybrids by 50% on the basis of nuclear DNA analyses (Puigcerver et al., 2007).

The first hybrid detected in Catalonia (Northeast Spain) was in 1990 (Rodríguez–Teijeiro et al., 1993), coinciding with the beginning of restocking practices involving farm–reared hybrids. Over the next 21 years, the number of censused hybrids (on the basis of call structure) was, on average, 2.2% of the total number of captured individuals, yielding a more reliable percentage estimate of 4.4 ± 0.66% hybrids, bearing in mind the underestimation inherent in the call method. During this period (1990–2011), there was no significant increasing trend in % hybrids (regression coefficient = 0.18 ± 0.17; R^2 = 0.001; $F_{1,20}$ = 0.028; p > 0.05; fig. 4), suggesting that hybrids are not a relevant distortion factor in the number of censused individuals (Puigcerver et al., 2007).

This result could 'a priori' be unexpected, because thousands of hybrid quails were sold each year until the late 1990s by professional game breeders in Spain, France and Italy for restocking prior to the opening of the hunting season (Guyomarc'h, 2003; Puigcerver et al., 2004). Under these conditions, a rapid increase in the proportion of hybrids in common quail populations would be expected, because once hybridization has begun (as Derégnaucourt et al., 2002 suggest), it is difficult to stop, especially if hybrids are fertile and mate both with other hybrids and with parental individuals (Allendorf et al., 2001). After a few generations, this process would result in a hybrid swarm in which essentially all individuals are of hybrid origin (Huxel, 1999; Allendorf et al., 2001), leading to a collapse of the pure migratory common quail population.

The low proportion of Japanese quails or hybrids captured (less than 5%) found in the last 21 years in Catalonia clearly suggests an extremely high mortality rate of released. It has been suggested that these birds are badly adapted to the wild, lacking the ability to defend themselves against cold, to forage for and select food, and to display anti–predator behaviour. (Guyomarc'h, 2003). This hypothesis is supported by data found in farm–reared red–legged partridges, where the global survival rate of 20 radio–tagged individuals was 15% three months after the release (Duarte &

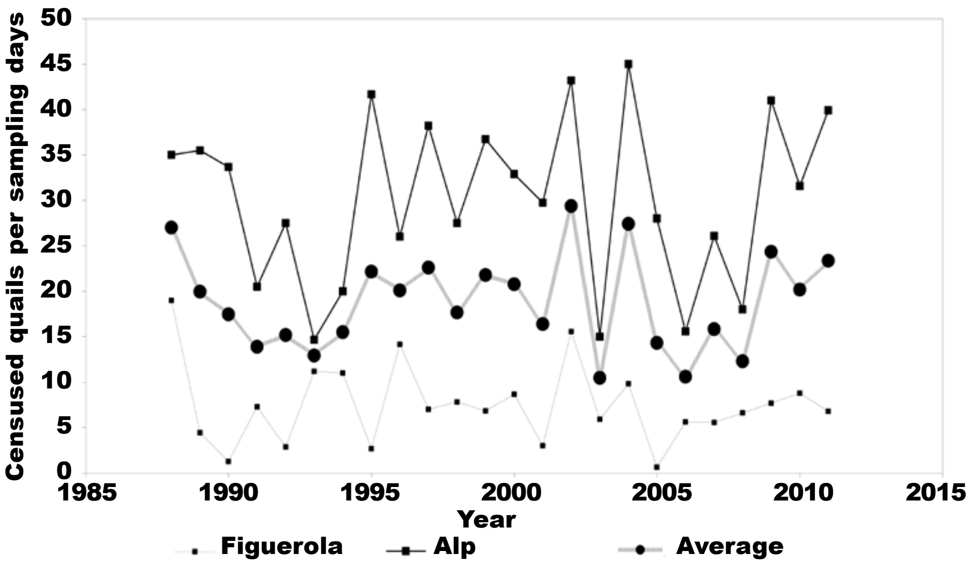

Fig. 4. Male quails in two breeding sites of Catalonia: Figuerola del Camp (41.23 N, 1.17 E) and Alp (42.23 N, 1.53 E) during the period 1998–2011, censused in Catalonia using the method of Rodríguez–Teijeiro et al. (2010). Grey line: average of censused males across sites.

Fig. 4. Codornices macho en dos lugares de cría de Cataluña: Figuerola del Camp (41,23 N, 1,17 E) y Alp (42,23 N; 1,53 E) durante el periodo 1998–2011 censadas en Cataluña utilizando el método de Rodríguez–Teijeiro et al. (2010). Línea gris: promedio de los machos censados en los emplazamientos.

Vargas, 2004). Furthermore, hunting practices may be a significant mortality factor for these restocked individuals; Guyomarc'h (2003) reports that, in a 64,000 ha sampling area of Haute–Garonne, 4,950 quails were hunted and 75% of them were restocked individuals. In spite of these past extensive restocking practices, our results show that they do not constitute a relevant distortion factor when censusing native breeding populations of common quail.

Ringing recoveries

To understand the maintenance of large–scale movement patterns, it can be helpful to explore the spatio–temporal dynamics of the resources making up the niche of a species. In particular, it is important to understand how predictability, variability and other statistical properties vary across space and time (Jonzén et al., 2011). In the case of the common quail, two of the described movements (altitudinal and aestival movements) are associated with habitat seasonality. Thus, cereal crops are, in general, ephemeral but predictable habitats; only meteorological variables provide a certain degree of unpredictability with regard to their capacity for holding common quail populations. This capacity is extended in time proportionally to the altitude of the site, so associations between the movements of the species throughout the breeding season and specific patterns of altitudinal landscapes can be predicted.

With regard to recoveries of individuals ringed in Spain (EURING database), results have clearly shown that in the northern half Spain, individuals ringed in the west have a preferred direction towards east, whereas individuals ringed in the east show a preferred direction towards the west. However, those individuals ringed between longitudes 5º W to 3º W do not show any preferred direction (fig. 1).

As the harvesting date for barley in Spain is positively correlated with elevation and latitude, harvesting in combination with some geographical relief acts as a funnel, forcing quail populations to concentrate with pre–migratory dispersive movements on the Castilian Plateau, particularly in the province of Burgos (Rodríguez–Teijeiro et al., 2009).

Thus, the analysis of ring recoveries is a useful method to understand movement patterns of common quails during the breeding and pre–migratory season.

Conclusions and management recommendations

It is clear that it is very difficult to determine population status in the case of the common quail. Generation of reliable population estimates for bird species is an important step towards determining their conservation status so as to develop appropriate conservation policies (IUCN, 2001), and as population monitoring is a top priority action recommended by the European Union

Management Plan for the species (Guyomarc'h, 2003; Perennou, 2009), it would be desirable to generalise the census methodology proposed in Rodríguez–Teijeiro et al. (2010) to the countries of the quail´s distribution area. This would strengthen our findings with respect to the stability of the Atlantic population, which is not the result of restocking practices.

The use of ring recovery data can reveal valuable information about common quail population movements. In the case of Spain, these data showed the existence of pre–migratory movements orientated towards the Castilian Plateau, where Spanish common quail populations concentrate before the opening of the hunting period. This information can be used to identify priority areas that deserve special attention in terms of conservation.

Finally, the development of a species distribution model is a promising tool for the management of the common quail. This model should be based on specific monitoring, reproducing the species dynamics, and taking into account temporal replicates per site. This would allow the inclusion of a larger number of conditions to estimate environment —species relationships, as suggested in Sardà–Palomera et al. (2012). Data from meteorological stations close to monitoring locations on temperature and precipitation during the breeding season would be desirable to relate male occurrence and densities with variations of climate and weather conditions. As the life cycle of this species is closely linked to the herbaceous farmland habitat, information on changes in the temporal development of vegetation should be included in the model to reflect variations in habitat suitability. One means of capturing an element of the phenology of these dynamic landscapes is through the use of vegetation indices (Pettorelli et al., 2005). These indices provide information about photosynthetic activity, vegetation cover and structure, and they are continuously collected via satellite via remote sensors. Such a model may indicate the suitability of habitats for quails in space and time, and may also help to predict possible conflicts arising from agricultural practices and from the start date of the hunting season.

Taken together, the data presented here may be useful for designing management and conservation measures for this species in order to improve its current and future conservation status.

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