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Avoiding over-implementation of agri-environmental schemes for steppe bird conservation: A species-focused proposal based on expert criteria

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A B S T R A C T

This study presents an assessment, resulting from consultation with experts in steppe-bird conservation (scientists, officers and conservationists) using the Delphi method, of a broad range of agri-environmental measures (AEMs) which have been applied in agricultural areas in Spain, with particular reference to four threatened steppe bird species. The measures which experts have valued most highly relate to the maintenance of fallow land, the prohibition of agrochemicals and the suspension of certain agricultural practices when the species are nesting. Other AEMs which have frequently been mentioned as beneficial for steppe birds, including the maintenance of straw-mulched fallows and the abandonment of farmland, were rejected by the experts. The assessment showed a high degree of consensus between experts, although differences between the four studied species were detected. Delphi assessment indicated that different birds need different AEMs. In addition, expert evaluation showed that different AEMs can cause the same effect on the target species, which could generate an over-implementation of measures. Finally, we evaluated the financial implementation of the AEMs selected by the Delphi using a Special Protection Area for birds (SPA) in the Madrid region as a case study. All the hypothetical scenarios used yielded assumable costs, oscillating between 1 and 2 times the current AEMs expenditure. In conclusion, in extensive agrarian systems with already high conservation merits, the implementation of AEMS could be improved using species-specific assessments, thus avoiding over-implementation and improving the fit between costs and benefits for conservation.

1. Introduction

The Common Agricultural Policy (CAP) was introduced with the objective of increasing agricultural production through maintaining prices and protecting against imports. In conjunction with modern technology this favoured intensification of agriculture on productive land and a parallel abandonment of unprofitable properties (extensive areas of low productivity) (Oñate, 2005). Although the CAP has achieved its objectives with respect to productivity, to date it has not contributed to stabilising the rural economy and it has had a pronounced environmental impact, causing a large decline in numerous taxa (see reviews in Robinson and Sutherland, 2002; Tscharntke et al., 2005). It has had a particularly marked effect on birds associated with agricultural areas, a group of species which is particularly threatened on a European scale (Donald et al., 2002; Sanderson et al., 2005), and especially for Mediterranean steppe birds (Suárez et al., 1997).

Successive reforms of the CAP have attempted to mitigate its negative effects (Oñate, 2005). Specifically, the agri-environmental measures (hereafter, AEMs) established under Regulation 2078/92 were conceived with the aim of compensating farmers for loss of income resulting from the use of environmentally friendly farming practices. Their principal objectives include a reduction in the use of pesticides and fertilisers, the protection of biodiversity, landscape restoration and prevention of rural abandonment. The European expenditure on AEMs amounts for 2007–2013 to nearly 20 billion EUR or 22% of the expenditure for rural development, including the co-financing by Member States (European Commission, 2006).

Despite this investment there is still little information regarding the effects of the AEMs on biodiversity. Some evaluations on the effectivity of AEMs have been carried out in different European countries, some of them showing positive effects (Marggraf, 2003; Primdahl et al., 2003; Berger et al., 2006; Marshall et al., 2006; Wrbka et al., 2008; Douglas et al., 2009), and some others

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indicating disparate ones (Kleijn and Sutherland, 2003; Báldi et al., 2005, Feehan et al., 2005; Kleijn et al., 2006; Wretenberg et al., 2007; Concepción et al., 2008) biodiversity. They agree that purpose-made investigations need to be carried out to permit an evaluation of the effectiveness of the measures in relation to the initial circumstances (see review in Kleijn and Sutherland, 2003). Moreover, there are few evaluations at the species-level (see e.g. Peach et al., 2001; Douglas et al., 2009) and incorporating these in the design might result in improvements in species conservation.

In recent years a number of evaluations of the effect of AEMs on the steppe avifauna have been carried out in some countries, including Spain, although these have been restricted to particular regions (Astraín and Zaragüeta, 2006; Kleijn et al., 2006; Concepción et al., 2008) and have given inconclusive results (see also Potts et al., 2006). In the particular case of Spain, the AEMs introduced to date are incomplete and of limited application (Llusía and Oñate, 2005).

On the other hand, although most authors agree on the types of measures needed to conserve steppe birds, they differ significantly regarding the design of some of these programmes, especially in relation to targets, timing, and to the extent of the areas involved. Studies assessing the effectiveness of AEMs yield negative results with respect to steppe and farmland bird conservation (Kleijn et al., 2001, 2006). The limited and often fragmented application of measures, in conjunction with very general design features which may introduce errors, may be reducing their effectiveness.

In this context, the present study attempts to employ expert-assessed criteria (from scientists, officers and conservationists) to evaluate the adaptation of AEMs which have been taken to date in pseudosteppe agricultural regions in Spain for conserving four threatened bird species associated with this habitat. On the basis of this evaluation, species-specific proposals based on a scientific consensus are made, with the aim of improving the current situation of those species in a Special Protection Area for birds (SPA/ZEPA) in Madrid region, central Spain. A cost is assigned to these proposals and possible avenues of finance by the EAFRD of the European Union identified.

2. Materials and methods

2.1. Study species

Four steppe bird species, the Great Bustard (*Otis tarda*), Little Bustard (*Tetrax tetrax*), Lesser Kestrel (*Falco naumanni*) and Montagu's Harrier (*Circus pygargus*) were selected. These four depend on cereal farmland and the principal threats to their conservation relate to agricultural intensification and alteration of their feeding and nesting habitats (Santos and Suárez, 2005). Their selection was based on the following criteria: (i) the high amount of available information on their basic ecology, and (ii) the broad functional spectrum they cover (including herbivores, insectivores and carnivores, as well as species depending on crop fields for nesting and on fallows for nesting and/or feeding). Therefore, these four species can reasonably be considered as an umbrella group for farmland bird assemblage. They are regarded as vulnerable or of special interest on a national level, according to the National Index of Threatened Species and the Spanish Breeding Bird Red Book (Madroño et al., 2004).

2.2. Establishing the initial proposal for agri-environmental measures

An initial proposal of 24 agri-environmental measures for conserving these species was drawn up from a review of scientific and technical literature on measures which have been found to be beneficial to the conservation of steppe birds in the Iberian peninsula (Barreiro et al., 2004; Madroño et al., 2004; Llusía and Oñate, 2005; Astraín and Zaragüeta, 2006; De la Concha et al., 2006; Kleijn et al., 2006; Lima et al., 2006). All the measures included in the initial proposal are currently being applied or form part of some plan or study and the majority relate to non-irrigated, herbaceous crops.

2.3. Evaluation of agri-environmental measures: the Delphi analysis

The Delphi methodology, which allows a collective view to be obtained distinct from a simple aggregate of individual judgments, was followed to evaluate the original proposed measures (Murry and Hammons, 1995). The Delphi method is based on the interrogation to experts using consecutive questionnaires with the aim to highlight and identify opinion agreements and establish potential consensus on the questions asked. This method, although rarely used in environmental assessments (see, however, Marggraf, 2003 and references therein, and Astraín and Zaragüeta, 2006), allows for a group communication process when dealing with complex questions for which information is scarce, yielding a collective view different from simple aggregation of individual judgments (Murry and Hammons, 1995).

The Delphi analysis was carried out in two successive stages based on responses to a questionnaire which was drawn up according to an initial proposal of agri-environmental measures and submeasures (i.e. time ranges for a specific measure; different dimensions as width of strips, etc.). The questionnaire, with no special reference to a specific area or region, was sent to a total of 39 experts belonging to three different professional fields: researchers, conservationists and officers of Public Administration. Replies were received from 20 of them (51.3%), 12 belonging to science, 7 to office administration and 1 to conservationists. In the first instance the experts were required to respond to the initial questionnaire. In the second stage each expert received a new version of the questionnaire, with the same options as the original version but including his or her own initial responses and also the mean values obtained from the whole of the specialist group. All the experts required in this second stage answered the questionnaire. This now gave each person the option of reaffirming his or her original response or of modifying it in the light of the new information provided. This method provides informative feedback whose outcome is to achieve a consensus in the experts' evaluation of each measure (Murry and Hammons, 1995). For a similar methodological approach, see Marggraf (2003) and Astraín and Zaragüeta (2006).

The experts were required to rate the suitability of each agri-environmental measure for the conservation of each of the four species on a scale ranging from $+5$ (highly beneficial) to -5 (highly unsuitable), recording 0 if a measure was judged to be inconsequential or irrelevant to a species' conservation. A score of 2.5 (i.e. above the 75th percentile) was taken as the acceptance threshold for including a measure in the final proposal, rejecting those measures which gave a negative value for any of the four species. Where measures received different evaluations for recommended intensity of application, the highest mean value for the four species was chosen. The measures included in the final proposals were grouped into programmes according to criteria related to the type of terrain involved (fallow land, cultivation or pasture).

The four species have been grouped according to their similarity in the evaluation obtained for all the measures and submeasures by means of a hierarchical cluster analysis, with single linkage as the amalgamation rule and squared Euclidean distances as the similarity criterion among measures. In addition, in order to relate the proposed measures to each species adequately, a Principal Component Analysis was performed on the correlation matrix of the mean evaluations obtained for each species for all measures and submeasures. Analyses were made with Statistica (Statsoft Inc., 2002) and Canoco for Windows (Ter Braak and Smilauer, 2004) programmes.

2.4. Application of the final proposals to a case study

We simulated the application of the final proposals for AEMs suited to the conservation of the four species to a specific case study of the Cereal Steppes of the Rivers Jarama and Henares in Madrid region (SPA/ZEPA n° 139). This SPA was designated in 1992 under the Birds Directive (Directive 79/409/CEE) which relates to wild bird conservation. It falls partly within one of the most important areas for steppe birds in Spain (Traba et al., 2007).

In order to test the applicability of our final proposals for AEMs an economic evaluation of the unit costs of their implementation (cost per hectare, or per livestock unit (LU) where applicable) has been performed. This follows the methodology used to calculate the amounts of agri-environmental subsidies and the reference values which appear in the Rural Development Programme for measures accompanying the CAP in Spain. The amounts of subsidies were established by calculating the losses of income occasioned to farmers through changing their means of production and the costs incurred, to which an incentive payment of 20% of the total has been added with a view to facilitate or encourage take-up of the programme. Current subsidies in Spain range from 10 to 900€ per hectare or per LU. 'Comparative scenarios' have been employed for some of the proposed measures, i.e. the costs have been estimated on the basis of applications of similar measures applied elsewhere in zones with characteristics similar to the study area (SPA 139). Readers can find a detailed description of the calculation methods for each measure. EU Rural Development Regulation n° 1698/2005, which relates to current support of rural development from the European Fund for Rural Development (EAFRD), was consulted to review possible avenues of finance for the proposed measures.

Finally, a projection has been made of the costs which would be involved in applying the measures proposed in this study to SPA 139 under three possible implementation scenarios. The first of these retains the current percentage take-up of AEMs, 8.4% of the area (the mean take-up area of municipalities in SPA 139, based on data supplied by the Directorate for Agriculture and Rural Development of the Madrid Community for 2002–2007). The second and third scenarios consider take-up of twice or three times this extent (16.8% and 25.2%, respectively). The alternative costing scenarios for applying the proposed measures in SPA 139 have been calculated on the basis of the areas currently occupied by different agricultural substrates, based on information available for two municipalities: Valdetorres del Jarama and Camarma de Esteruelas (Delgado et al., 2009).

3. Results

3.1. Measures accepted or rejected by the Delphi analysis

The Delphi selection process allowed proposed measures to be obtained with a high degree of consensus, reducing the standard deviations of responses after the second circulation. Only measures relating to timing, to maintaining uncropped areas and to withdrawing land from production showed standard deviations greater than 2.

All the proposed measures in the questionnaire received a positive evaluation from the experts for the four species with the exception of land set-aside from cultivation for longer than 20 years, which was considered to have a negative impact on all four. Numerous measures were, however, below the threshold for acceptance and hence have not been included in the definitive proposals (see Table 1). This applies, for instance, to setting-aside land from cultivation for periods of four or five years, oversowing of cereals, sowing tall plants to provide a faunal refuge over less than 10% of the area (which only obtained high evaluations for the Great Bustard) and prohibiting grazing during the nesting seasons. Environmental fallows with straw mulch were valued at near zero (even slightly negatively for Montagu's Harrier) as was maintaining uncropped areas around nests (Table 1).

Conversely, measures which were considered very positive (valued at over 4 points) were prohibiting working of fallows between 1 April and 15 July, prohibiting nocturnal harvesting, prohibiting the use of agro-chemicals (fertilisers plus pesticides, in both crops and fallows), prohibiting extension of irrigation and promoting organic farming (valued at nearly 4, Table 1). The AEMs valued above the acceptance threshold have been grouped into four programmes, on the basis of criteria related to the type of terrain involved: fallow land, cultivation or pasture. Measures relating to promoting or prohibiting new production methods have been grouped in a different programme.

Programme 1. Conditioning environmental fallows for faunal protection.

Programme 2. Conditioning cultivation for faunal protection (environmental sowing).

Programme 3. Measures relating to promoting or prohibiting new methods of production.

Programme 4. Livestock management and maintenance of pastures and set-aside land.

Each of these programmes would require compliance with the measures it included. In addition, programmes 1 and 2 include measures which farmers could implement, in addition to complying with the general programme requirements.

3.2. Evaluation by species

The hierarchical classification of the mean expert evaluations obtained for the four species showed a clear grouping between the two most phylogenetically and ecologically closest species (the Great and Little Bustards, chiefly herbivorous members of the bustard family) and segregated the other two species (Fig. 1), both of them raptors with a high dependence on insect availability. This result indicates a greater similarity in the types and evaluations of measures considered suitable for the two bustards, those proposed for the two raptors clearly being different. This lack of correspondence between species in the proposed measures was also detected by the PCA, which proved highly explicative, explaining 97.2% of the variance in its first two axes. The biplot of measures and species confirmed the segregation in the type of measures thought suitable for each species (Fig. 2), specifically defining two (ploughing stubble for seeding after 1 August and leaving uncropped margins around nests) for Montagu's Harrier and one in particular (organic farming) for the Lesser Kestrel. Nevertheless, a high level of imprecision is revealed in defining measures and submeasures in the cases of the two bustards, given that practically half of them are positively evaluated for these two species (Fig. 2).

3.3. Costs and financing of the proposed measures

The analysis of possible avenues of finance for the final proposals shows that all could be funded via EAFRD under Axis 2 (Environment) of the Rural Development Regulations. With the exception of prohibiting extension of irrigation, all the measures

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Table 1
Mean and standard deviation (SD) of the values assigned to each measure and submeasure by the experts after the two rounds of the Delphi analysis.

Measures	Submeasures	M. Harrier		L. Kestrel		G. Bustard		L. Bustard		4 spp	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
a. Environmental fallows	a1. One-third of area	2.8	1.7	2.6	1.5	3.4	1.8	2.6	1.5	2.9	1.5
	a2. Alternate years	2.9	1.3	3.4	1.4	3.7	1.4	3.5	1.4	3.4	1.2
	a3. Two-thirds of area	1.4	2.1	3.3	1.9	2.6	1.7	3.5	1.9	2.8	1.6
b. Fallows unworked during	b1. 1 April–31 May	2.4	1.1	1.6	1.2	2.6	1.3	2.8	1.1	2.4	0.8
	b2. 1 April–30 June	3.5	0.9	2.3	2.3	4.2	0.5	3.8	1.2	3.5	0.7
	b3. 1 April–15 July	3.9	1.2	2.9	2.7	4.9	0.2	4.6	1.3	4.1	0.8
c. Environmental fallows with straw mulch		−0,3	1.9	0.8	1.2	0.3	1.6	0.3	1.7	0.3	1.2
d. Fallows seeded with legumes	d1. Ungrazed	1.6	1.2	0.9	1.5	3.9	1.3	3.7	1.3	2.7	1.0
	d2. Grazed	1.5	1.3	1.0	1.8	3.9	1.1	3.7	1.2	2.7	0.9
e. Fallows seeded with legumes	e1. 10% of area	1.6	1.0	1.4	1.7	3.5	0.9	3.6	0.9	2.6	0.7
	e2. 20% of area	1.8	1.3	1.6	2.3	3.8	1.5	3.8	1.6	2.9	1.3
f. Oversowing		0,8	1.6	−0.1	0.8	0.9	1.4	0.7	1.3	0.6	1.1
g. Avoidance of short-cycle varieties		4,1	1.5	0.2	1.7	3.7	1.8	3.7	1.5	2.9	1.4
h. Harvest delayed	h1. Until 15 June	0.6	2.7	0.7	2.1	0.9	2.6	0.9	2.3	0.9	2.0
	h2. Until 1 July	3.2	1.7	0.4	2.0	3.4	1.3	3.3	1.4	2.7	1.2
	h3. Until 15 July	4.9	0.5	0.0	2.2	4.4	1.3	4.3	1.3	3.5	0.9
i. No nocturnal harvesting		4,8	0.4	1.4	1.9	4.9	0.3	4.9	0.3	4.1	0.6
j. Stubble raised in sown fields	j1. From 1 August	0.2	2.3	−0.5	2.0	−0.6	2.5	−0.5	2.4	−0.4	2.1
	j2. From 15 October	2.5	1.9	1.4	1.9	3.9	0.9	3.9	1.0	3.0	1.0
k. Stubble raised in fallows	k1. until 1 February	1.2	1.6	1.0	1.4	3.4	1.0	3.5	1.0	2.4	0.9
	k2. until 1 March	1.3	1.6	1.2	1.2	3.4	1.1	3.4	1.2	2.4	1.0
l. Organic production		3,9	1.1	4.1	0.9	3.9	0.9	3.9	0.9	3.9	0.9
m. Agro-chemicals	m1. Prohibited	4.4	1.1	4.5	0.6	4.5	0.8	4.5	0.8	4.4	0.8
	m2. Toxicity AAA/AAB	2.5	1.8	2.6	1.7	2.5	1.8	2.4	1.8	2.5	1.7
n. Use of treated seeds	n1. Prohibited	2.4	1.6	2.3	1.7	3.7	1.3	3.8	1.2	3.0	1.2
	n2. Toxicity AAA/AAB	1.6	1.5	1.5	1.6	2.4	1.7	2.4	1.7	2.0	1.5
o. No agro-chemicals on fallows/stubbles		4,1	1.0	4.5	0.7	4.6	0.6	4.6	0.6	4.4	0.7
p. Land set-aside	p1. For 4 or 5 years	1.5	2.8	1.8	2.8	1.8	2.9	2.1	3.1	1.8	2.6
	p2. For 20 years	−1.4	3.1	−1.1	3.4	−1.3	3.1	−0.6	3.5	−1.1	3.1
q. Maintenance of set-aside	q1. by mechanical clearing	0.2	2.5	0.3	2.4	0.4	2.2	0.1	2.2	0.3	2.2
	q2. by grazing	2.8	2.1	3.3	1.8	3.5	1.2	3.6	1.1	3.3	1.5
r. Uncropped margins	r1. 1–2 m wide	2.7	1.0	2.9	1.4	3.4	1.1	3.6	1.0	3.1	1.1
	r2. 3 m wide	3.2	1.4	3.1	1.7	3.8	1.7	4.1	1.3	3.4	1.5
s. Uncropped areas around nests		0,9	3.2	0.1	0.3	−0.1	2.4	0.2	2.3	0.2	1.8
t. Planting tall plants over <10% of area		−0,1	1.4	−0.8	1.6	1.6	2.1	0.6	1.8	0.5	1.6
u. Prevention of new irrigation		4,4	1.1	4.3	1.5	4.7	0.5	4.2	1.6	4.3	1.0
v. Pasture maintenance	v1. sward depth <20cm	3.4	1.1	3.6	1.2	2.9	1.5	3.4	1.6	3.3	1.2
	v2. sward depth >20cm	2.2	1.3	1.3	2.1	3.1	1.3	2.6	1.4	2.4	1.3
w. Adjustment of grazing load	w1. 0.2 to 0.5 LU	2.3	1.7	2.1	1.6	2.9	1.6	3.0	1.5	2.5	1.5
	w2. 0.5 to 1 LU	1.0	1.6	1.4	1.6	1.4	1.5	1.8	1.6	1.3	1.5
x. Grazing avoided	x1. From March to July	0.9	2.2	0.1	2.1	1.9	2.3	1.9	2.3	1.3	2.0
	x2. From April to July	0.8	2.2	0.2	2.2	2.3	2.5	2.4	2.5	1.6	2.2

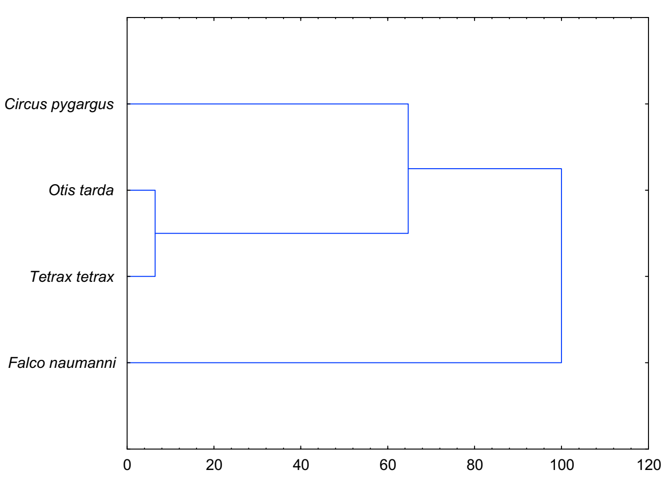

Fig. 1. Single-linkage-joining tree of 4 species of steppe birds based on the squared Euclidean distances as the similarity criterion among the evaluations obtained for all the measures and submeasures.

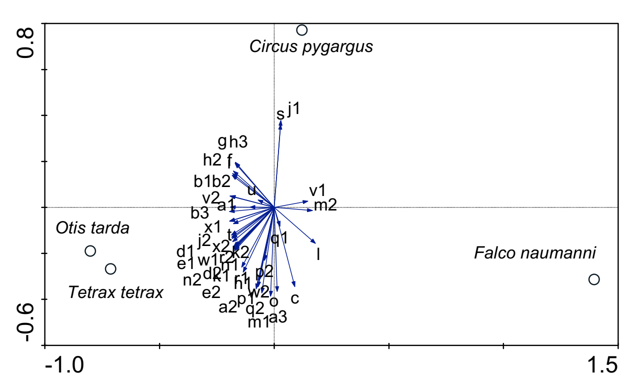

Fig. 2. Biplot of species-measures obtained from the projection of factor scores for two first factors of the Principal Component Analysis performed on the correlation matrix of the mean evaluations obtained for each steppe bird species for all measures and submeasures. Letters and numbers refer to classification of measures and submeasures as presented in Table 1.

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could be included as environmental support, whose maximum level is 600€/ha for annual crops. In addition, some of these measures are directly related to conservation of species included in the Birds Directive so that they could also be funded via Natura 2000. With respect to prohibiting extension of irrigation, obligatory measures which limit changes in irrigation may be applied in Natura 2000 sites, and measures to manage and maintain non-irrigated croplands may be financed via that programme (EU Birds Directive, 79/409/CEE).

3.4. Application of the proposals to alternative scenarios

To calculate the alternative cost scenarios of applying the proposed measures to SPA 139 the 'environmental fallows' programme has been applied to the area of short-term fallows, the 'environmental sowing' programme to cultivated and ploughed areas and the 'livestock' programme to long-term fallows and uncultivated land. The 'organic farming' measure has not been considered since the 'environmental sowing' programme broadly incorporates its provisions, including the prohibition of agro-chemicals and with a view to avoiding duplicating costs for the same substrate, since the cost of the former is only slightly greater. There are no existing plans for crop irrigation in the zone and thus no costs associated with prohibiting its expansion.

Current expenditure on AEMs in SPA 139 are 225,021.96 €/year (Department of Agriculture, Government of Madrid), applied over an area of 4.085 hectares. The estimated cost for implementing AEMs over a similar area under scenario 1 in SPA 139 is 133,058 €/year. If the cost of the additional programmes (compensation for the effect of infrastructure constructed within the zone) is included, the approximate annual cost would be 297,386€. When this total is compared with the three proposed scenarios it is evident that scenario 1 is compatible with current expenditure within the study area (Table 2). Scenario 2 would involve an additional cost of 154,539 €, 52% greater than current expenditure. Scenario 3 would imply costs twice as great as current expenditure within the SPA (Table 2).

4. Discussion

The expert consultation regarding the suitability for four species of steppe birds of AEMs currently being applied in Spain has allowed possible shortcomings in the design of these to be detected and has permitted proposals which would accord better with the requirements of each of the species. The recommended measures centre on the maintenance of fallows, the prohibition of agro-chemicals and the suspension of certain agricultural practices when the species are nesting, although the measures which most suit each species may differ. The final proposed measures have been shown to be supported by expert criteria and financially affordable.

Table 2
Extent and annual cost of application of each of the agri-environmental programmes proposed under the three alternative scenarios.

Programme	Scenario 1		Scenario 2		Scenario 3	
	Extent (ha)	Cost (€)	Extent (ha)	Cost (€)	Extent (ha)	Cost (€)
Environmental fallows	394	72,924	787	145,848	1181	218,772
Environmental sowing	1749	141.264	3499	282,528	5248	423,792
Livestock management	273	11,775	545	23,549	818	35,324
Total	2416	225,963	4831	451,925	7247	677,888

Applying implementation scenarios to a study case show that an area similar to that which is currently receiving agri-environmental funding could be financed at less than current costs and that improvements over an increased area could be financed at a lower cost.

4.1. Evaluation of agri-environmental measures

The questionnaire to experts on the suitability of measures currently applied in different steppe areas of Spain has been useful to identify possible drawbacks in the design of those being implemented in the study SPA to allow improvement proposal. The Delphi method, although scarcely used in this kind of studies (see, however, Marggraf, 2003; Astraín and Zaragüeta, 2006), has proved to be useful in decision making (Murry and Hammons, 1995). In relation to AEMs, there are still few assessments of their effectiveness in Spain and therefore expert criteria can be considerably helpful in their design and improvement. Nevertheless, the results obtained must be empirically tested before drawing definitive conclusions on the suitability of measures proposed.

The Delphi analysis results have shown a consensus between experts in the evaluation of most of the measures considered. Also, it is important to emphasize here that all measures identified by experts as beneficial to the different study species are consistent with their respective ecological requirements as shown by the existing scientific literature (see Table 3). Nevertheless, significant variation, greater than 2 points, has been found in the evaluations of some questions, specifically regarding measures concerning dates, the maintenance of uncultivated field margins and setting-aside land from production. These higher levels of disagreement show a lack of expert consensus regarding the temporal planning of measures (application dates, duration of set-aside periods, etc.) which, in turn, may result from a certain lack of information on the species' response to differences in these factors. In some cases, the drafting of the questionnaire may have complicated the experts' evaluations since highly complex questions have needed to be simplified. An example of this is the question relating to the ideal start and end dates for agricultural activities, which in practice depend on weather conditions during the year in question and on the phenology of nesting of each species in each area: expert assessments here have always rated the most restrictive option most positively. Most of the initially proposed measures were positively evaluated by the experts and several of them were regarded highly positively. This is the case with the prohibiting working fallows between 1 April and 15 July, prohibiting nocturnal harvesting, prohibiting the use of agro-chemicals (in both in crops and fallows), promoting organic farming and prohibiting expansion of irrigation. On the other hand, the negative or near-zero evaluation given to some measures in the questionnaire shows that not all current practices are regarded by experts as beneficial to steppe birds, which indicates design limitations. This applies to the case of setting-aside land from cultivation for twenty years, which is actually considered deleterious for the four species. It corresponds with current views that abandonment of agricultural land is a threat to the farmland steppe species on which the study is based (Suárez et al., 1997; Suárez-Seoane et al., 2002).

Maintaining uncropped margins of 2 m around nests has also attracted assessments close to zero. Some experts have indicated that these small areas may make nest locations more easily detectable by predators. The measure has no relevance to the Lesser Kestrel, which nests in buildings. Straw-mulched fallows also received an evaluation close to zero (and slightly negative for Montagu's Harrier), probably because experts consider it more as a disturbance than a benefit for birds. As it happens, this is one of

Table 3
Main habitat requirements of the study species described in literature, and resources obtained by them when these requirements are met. References are fully listed in Appendix 2 of the Supplementary material.

	Habitat requirement	Resource provided	References
Great Bustard	Dominance of cereal fields	Main nesting habitat	Morgado and Moreira (2000); Magaña et al. (2009)
	Some degree of culture diversity (presence of fallows, leguminous crops)	Lekking sites, feeding habitat	Lane et al. (2001); Moreira et al. (2004)
Little Bustard	Culture diversity/significant fallow cover	Lekking, nesting, and feeding habitat	Salamolard and Moreau (1999); Morales et al. (2005); García et al. (2007); Traba et al. (2008)
	Varying vegetation density	Suitable male display and nesting sites	Morales et al. (2008)
Montagu's Harrier	Dominance of cereal fields	Nesting sites	Castaño (1995); Arroyo et al. (2002)
	Some degree of culture diversity (presence of fallows, leguminous crops)	Foraging areas	Arroyo et al. (2004)
Lesser Kestrel	Culture diversity/significant fallow cover	Foraging areas	Tella et al. (1998); Tella and Forero (2000); Franco and Sutherland (2004)
	Relatively low vegetation cover (stubbles, grazed pastureland)	Enhanced prey availability	García et al. (2006)

the few measures currently being applied in SPA 139, where it absorbs more than half of the present expenditure on agri-environmental measures in the study area. Setting-aside land from production for a period of four or five years is another measure which is currently being applied within the study area but which nevertheless has been excluded from the final proposals since its expert evaluation did not reach the acceptance threshold. The expert view does not consider imposing restrictions on grazing during the nesting season to be relevant, which may lead to a reappraisal of the usefulness of this measure which is frequently applied in other areas in Spain.

These results show a high level of concordance when comparing with those of the only similar study so far carried out in Spain (Astraín and Zaragüeta, 2006). In both cases agricultural measures were more highly rated than those concerning livestock. Nevertheless, withdrawing land from production and oversowing were highly rated in the cited work unlike in the present study, which may be due to the species-specific approach used here. Indeed, the four species included in our study are especially dependent on cultivation (Santos and Suárez, 2005), which once again emphasises the importance of taking the target species into account (drawing up a sound design).

In this respect, evaluation of measures according to species is an innovative methodology which may be useful regionally in targeting measures according to the species-conservation priorities of particular zones. The Delphi results have shown that there may be measures which are beneficial for certain species and deleterious to others. An example is sowing tall-growing plants to provide shelter for fauna, which is negatively rated for the Montagu's Harrier and the Lesser Kestrel. This measure has been proposed for the Great Bustard (De la Concha et al., 2006) although its evaluation in the present study also failed to reach threshold acceptability for this species. Evaluation by species may also be useful when designing packets of measures for some species and for detecting problems of over-implementation, in the sense of employing redundant measures, in other cases. Hence the Delphi results indicate that measures relating to mortality in the nest (avoiding short-cycle crop varieties, delaying harvest, prohibiting nocturnal harvest or prohibiting grazing during the nesting season) are irrelevant in the case of the Lesser Kestrel, which is not a ground-nester. At the opposite extreme, the species-specific analysis showed a high level of imprecision in the measures proposed for the Great and Little Bustards, despite their biology and ecology being very well known. Basically, the experts identified numerous measures as positive for these species, without obvious preferences for any of them, which makes it hard to develop packets of measures specifically for them and which carries a risk of over-implementation.

4.2. *Applicability of the proposals. Economic evaluation and sources of finance for the proposed measures*

The final proposals comprise a packet of four measures related to: (i) development of land temporarily set-aside from production for faunal protection (environmental fallows); (ii) development of cultivated land for faunal protection (environmental sowing); (iii) promoting or prohibiting new systems of production, and (iv) livestock farming (including maintenance of pastures and land withdrawn from production). These proposals differ from the measures currently being applied in the SPA studied, which is not unexpected considering the deficiencies in the Spanish programme of AEMs which has been applied to date (lack of regional targeting at SPAs and other protected areas, small number of farming practices included as commitment, etc., Llusía and Oñate, 2005).

The financial evaluation of the measures proposed for the SPA has been drawn up according to the reference values given in the Spanish Rural Development Programme for 2000–2006, which may be employed in future as a function of certain indicators such as variation in the Consumer Price Index (CPI) or the increase in the price of certain products (such as the recent and very significant increase in the price of wheat). The methodology employed may prove useful for future estimates and predictions and provides a frame of reference for costing the proposed measures. Through analysing the new Rural Development Regulations of the EU (Regulation CE n° 1698/2005) it has been established that financing (or co-financing) all the proposed measures is possible through EAFRD, whether via agro-environmental funding or via Natura 2000 funding. Priority should be given to applying AEMs in high-value zones whose conservation depends on the agricultural practices requisite for environmental protection. This applies to extensive agricultural regions important for conservation of steppe birds, as in the case of the SPA studied (Traba et al., 2007).

5. Conclusions

The ineffectiveness of agri-environmental programmes in meeting their aims has previously been indicated (see, e.g. Kleijn and Sutherland, 2003; Kleijn et al., 2001, 2006), design shortcomings and the absence of attainable objectives being considered partly responsible for this lack of success (Paniagua, 2000; Kleijn and Sutherland, 2003; Bro et al., 2004; Oñate, 2005; Potts et al., 2006). The present proposals attempt to mitigate deficiencies related to over-implementation and inadequate design by developing a consensual packet of measures, agreed by scientists and managers, which directly takes target species into account and which guarantees affordability.

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Application of the AEMs should guarantee the maintenance of ecological exchanges between zones where measures compatible with species-protection are being employed, avoiding implementation in spatially isolated areas (Oñate, 2005; Whittingham, 2007). In this respect, the third proposed scenario, which implies a take-up of around 25% of the area of the SPA, tends to minimise this effect, costing only a little more than twice current expenditure, which could be reduced if application of superfluous measures is avoided. For example, if a farmer takes up measure 1, which involves having fallows in alternate years, and also wants to take up measure 2, involving environmental sowing, the additional submeasure 2.1, on maintaining uncropped margins, would be an unnecessary superfluity and avoiding it would reduce costs by 7%.

Finally, and as suggested by some authors (Tscharntke et al., 2005), it must be emphasised that application of AEMs would be especially important in zones which are subject to intermediate levels of intensification, resulting in increases in the abundance of common species (something already detected by Kleijn et al., 2006, see also Concepción et al., 2008). In extensive zones, such as the study area, less investment on traditional agri-environmental measures may be necessary and instead the funds, which are partly intended to prevent rural abandonment, may be otherwise distributed. As indicated by Oñate (2005), one possibility would be to broaden the eco-conditionality requirements (obligatory restrictions) and accompany them with packets of specific measures, costly but effective, in those zones where they are needed (see also Potts et al., 2006; Whittingham, 2007; Wrbka et al., 2008). Astraín and Zaragüeta (2006) also suggest employing low cost measures of a horizontal nature which are easily and widely applied and others of a vertical character which are complex, area-limited and directed at the conservation of particular threatened species, which would limit the effect of over-implementation. From our point of view, another possibility, which is indeed compatible with the former, would be to pay for environmental services in such way that extensive zones which are particularly rich in biodiversity (such as the Iberian steppe SPAs, Traba et al., 2007) could receive payments in the 'Natura 2000 assistance' of EAFRD, so that positive externalities may be adopted and assistance given to avoid rural abandonment.

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Appendix A. Supplementary information

Readers interested can find more information on the methodology for costing the proposed measures, costs obtained for each of the proposed agri-environmental programmes, the calculation methodology, and a summary with the final proposed programmes including the requirements of each suggested measure, its costing and the possible funding sources. Additionally, the reader can find a detailed list of the references used in Table 3, in the online version, at doi:10.1016/j.jenvman.2010.03.018.

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