Species selection to develop an Italian farmland bird index

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Abstract – The authors present a trial to identify a species-set on which building up an Italian national farmland bird index. Using the data of MITO2000 project (2000-2003 years), logistic regression functions were built for 98 species, selected from the 103 target species of the project, relating their presence with the surface of Corine land cover categories (II or III level). Each species was associated with a particular land use category according to the first variable selected in the model through a stepwise procedure, taking into account only positive relationships. Out of the original 98 species, 44 showed a significant response to one of the 'farmland' land use categories, with a good correspondence with the known ecology of the species.

INTRODUCTION

Farmland transformation that has occurred in Europe over the past 50 years (Meeus *et al*. 1990, Bouma *et al*. 1998, for Italy see Nanni 2002) have led to a dramatic decline in biodiversity (Davidson and Lloyd 1977, Robinson and Sutherland 2002). This biodiversity decline has been widespread over the whole continent, concerning in particular birds (Tucker and Heath 1994, Tucker 1999, Fuller 2000, Burfield and Van Bommel 2004). Besides a general socio-economic change, several causes have been involved in this transformation, but all may be related to modernization of agricultural techniques (Chamberlain *et al*. 1999, Chamberlain *et al*. 2000, Benton *et al*. 2002). The shift from an extensive management of farmland to intensive agricultural practices has reduced the environmental diversity typical of traditional rural areas (Fuller 1995, Stoate 1996, Krebs *et al*. 1999, Chamberlain *et al*. 2000). The important role of farmland for biodiversity maintenance is confirmed by the fact that it hosts the majority of bird species of conservation concern, so their preservation is considered a priority (Tucker 1997). Recent investigations have highlighted that at least 60% of open-habitat bird species decreased significantly in the period 1970-2000 (Burfield and Van Bommel 2004). The awareness of the importance of combining crop productivity with biodiversity conservation has determined an increasing attention towards sustainable farming practices, and has favoured specific actions addressed to the restoration of natural patches in the agricultural landscape (Sanderson *et al*. 2005). One of the main aims of the new Common Agricultural Policy (CAP) regards the reduction of the negative trend that affects biodiversity, entrusting each European country with this specific task (de la Concha 2005, Oñate 2005). In this context, developing a set of ecological indicators appears a basic tool to monitor the effectiveness of actions and measures of agricultural plans for biodiversity conservation. In a growing series of instances, birds have been selected as such indicators (Van Strien 2004, Julliard *et al*. 2004, Gregory *et al*. 2005). The choice of birds is due to their sensitiveness and prompt response to the changes of the most important environmental factors (structure and composition of vegetation, degree of environmental pollution, climate, etc.; Diamond and Filion 1987, Koskimies and Väisänen 1991, Wilson and Fuller 2001). In particular, birds are considered among the best indicators of biodiversity status in agricultural systems (Sauberer *et al*. 2004).

Although almost all European countries have activated specific projects of bird population monitoring (Van Strien *et al*. 2001, EBCC 2004), more information is necessary, above all in Mediterranean regions where the available data on population trends are still localized and are not useful for large scale evaluation (Tellini Florenzano 2004, Santos 2000).

In this paper we identify a set of species suitable to define an Italian farmland bird index (FBI). For this purpose we have used the data of MITO2000, the Italian Bird Monitoring Scheme (Fornasari *et al*. 2004).

STUDY AREA AND METHODS

The MITO2000 project was aimed at monitoring each of the 181 Italian 50 x 50 km UTM grid units (primary unit, PU). In each PU, four 10 x 10 km secondary units (SU) out of the existing 25 were randomly selected and 15 point counts were planned for each selected SU; point count location within SUs were also randomly selected by extracting 15 (out of 100) 1 x 1 km squares. Each point count was carried out as close to the centre of the square as possible. All birds identifiable by sight or song were recorded during 10-min point counts in two distance belts (< 100 m and > 100 m from the observer). Point counts were carried out in the May-June period.

To select the species typical of agricultural environments, we used the data collected in the whole Italian territory in the first four years (2000-2003) of MITO2000 project. Since some points-counts were repeated in different years, we considered only data collected in the first year in which each point was visited. We obtained a sample of 18329 point-counts. In the analysis, we started with the list of 103 target species selected for national monitoring (Fornasari *et al*. 2004), excluding those ones with a limited number of observations (present in less than 50 point-counts) up to a final list of 98 species.

We have identified the land use category (expressed as surface area) better related to the presence of each species by means of logistic regression with an automatically stepwise procedure. Land use categories are those of CORINE Land Cover database (Büttner *et al*. 1998). The surface of each CORINE category was gathered inside a 100 m radius circle around each point-count directly by field collectors of Mito2000 project (Fornasari *et al*. 2002). The categories used for the analysis (Table 1) were established: 1) taking into account the necessity of defining in greater detail the preferences for agri-pastoral environments; 2) pooling the categories that are interpreted in a excessively different way by the field collectors (according to empirical verification with some of them); 3) favouring an approach that has brought out the vegetation structure more than the origin of the categories (e.g., green urban areas were pooled with woods), since habitat selection by bird species is largely due to structural elements (e.g. Cody 1985).

For each species, the point counts where it occurred were compared with as many points where it was absent (randomly selected in the sample, Manel *et al*. 2001) to identify the variable out of the 12 investigated categories (see Table 1) that was better related to the species presence (Wald statistics), considering only positive relationships. This procedure, addressed to select only one variable, enables to compare also variables clearly autocorrelated (e.g., one pooled variable and the original variables that form it, Draper and Smith 1998).

Finally, we considered only the species that were related to a 'farmland' variable (C-E and upper level groupings: N-R, see Table 1). Besides highlighting the response of single species, this procedure enables also to identify groups of species affected by the same variable (e.g., permanent crops or grassland). In addition, angular coefficient of the logistic regression (Hosmer and Lemeshow 2000) and the Area Under the ROC Curve (AUC, see McQuarrie and Tsai 1998), give a quantitative measures of the relationship between species occurrence and the selected variable. It has to be noted that dealing with single variable models, ROC values are necessarily low. Nevertheless, the two showed values (ROC and angular coefficient) permit to compare response of different species to farmland variables.

Except the correlation between pooled variable and the original variables that form it, the 'farmland' variables and the other variables (wood, urban, etc, see Table 1), were poorly correlated (Spearman rank correlation < 0.5) reducing the possible problem of high colinearity between variables.

RESULTS AND DISCUSSION

Out of the original 98 species, 44 (45%) showed a significant response to one of the 'farmland' variables. In particular, eight species were associated with the N category (all agricultural and open land categories); 9 with the M category (agricultural landscapes); 2 with the R category (herbaceous land); 2 with the D category; 17 with the C category and 6 with the E category (Tab. 2).

The correspondence between the known ecological requirements of the species and our results appears good. The majority of species were associated with the surface occupied by "natural grasslands, pastures and sparsely vegetated areas". This result confirms the importance of pastures and extensive zootechnical activities for the conservation of a high number of species (Redecker *et al*. 2002), above all in mountain areas. *S. curruca* and *S. borin* are linked to mountain edge and shrubby habitats; their primary response to grassland might be related to the fact that in our sample there are many patchy situations or shrubby

Table 1. Land use categories used for logistic regressions. Some 'farmland' land use categories were obtained pooling categories of the lower level: III level category, N = R + M; II level categories, R = C + D and M = D + E.

Level			land use category	Corine code
III	II	I		
		A	Forests	3.1
			Green urban areas	1.4.1
		B	Shrubs	3.2.2
			sclerophyllous vegetation	3.2.3
			transitional woodland shrub	3.2.4
		C	Natural grasslands	3.2.1
	R		Pastures	2.3.1
N			sparsely vegetated areas	3.3.3
		D	Arable land	2.1
	M	E	Permanent crops	2.2
			heterogeneous agricultural areas	2.4
		F	Artificial surfaces	1.1; 1.2; 1.3
		G	Wetlands	4
			inland water	5.1
		H	Seawater	5.2
		Z	Open spaces (except sparsely vegetated areas)	3.3

grassland. A high number of species (19) was significantly related to the three variables that were selected pooling categories of the lower level. Therefore, many species accept different kinds of agri-pastoral land uses, provided the availability of open habitats is adequate. Only two species were associated with each of the two categories "herbaceous land" and "arable land", i.e. the more homogenous environments among the land use categories taken into account. In the first case, the involved species were *Coturnix coturnix* and *Aluda arvensis*, two species typical of grassland and steppe throughout a large set of altitudinal and geographical conditions; in the second case, the species were *Motacilla flava*, typical of lowland cultivated areas, and *Corvus cornix*, a generalist species that perhaps is mostly diffuse in wide cultivated lands.

Except *Buteo buteo*, *Delichon urbicum*, *Cettia cetti*, *Hippolais polyglotta*, *Carduelis cannabina*, and *Emberiza cia*, the other species which were used to produce the Italian version of the Pan-European FBI (*Falco tinnunculus*, *Streptopelia turtur*, *Upupa epops*, *Galerida cristata*, *Alauda arvensis*, *Hirundo rustica*, *Motacilla flava*, *Motacilla alba*, *Luscinia megarhynchos*, *Saxicola torquata*, *Cisticola juncidis*, *Lanius collurio*, *Pica pica*, *Corvus corone cornix*, *Sturnus vulgaris*, *Passer italiae*, *Passer hispaniolensis*, *Passer montanus*, *Serinus serinus*, *Carduelis chloris*, *Carduelis carduelis*, *Milaria calandra*) showed a significant response to one of the 'farmland' variables' (Table 2). However, other 16 species that were not included in the list for the Italian FBI were significantly related to 'farmland' variables' (Table 2).

CONCLUSIONS

Our analysis contributes to the correct identification of the species mostly related to the agricultural landscape with an objective procedure that appears more trustworthy than an approach based on expert opinion. Our set of species included also species with large ecological needs that often are arbitrarily excluded by expert judgement (Heldbjerg 2004). Mending and refinement of this set of species are possible, but they have to be conducted according to unbiased criteria. For example, species characterized by high annual fluctuations due to their biology (e.g., *Coturnix coturnix* see Gregory *et al*. 2005) or weather variations (e.g., *Cisticola juncidis*) might be excluded. These species might be identified with the data of monitoring projects such as Mito2000.

Due to the articulate response of the identified species to different environmental variables, our set of species seems appropriate to satisfactorily represent the richness of rural landscapes present in Italy. In addition, this might enable more detailed analyses emphasizing, for example, the responses to specific environmental changes.

Table 2. List of species whose occurrence was significantly related with one of the "farmland" categories (land- use cat.; see Table 1 and Methods); for each species, besides the number of point counts in which it occurred (N+), the values of the AUC (ROC) and angular coefficient of the logistic regression (a) are given.

species	N+	land-use cat.	a	ROC
Falco tinnunculus	1222	N	0.012	0.618
Melanocorypha calandra	74	N	0.046	0.825
Calandrella brachydactyla	155	N	0.038	0.808
Saxicola torquata	1870	N	0.019	0.664
Sturnus vulgaris	3983	N	0.015	0.643
Sturnus unicolor	439	N	0.012	0.613
Emberiza hortulana	111	N	0.019	0.652
Emberiza calandra	2013	N	0.023	0.704
Coturnix coturnix	518	R	0.025	0.747
Alauda arvensis	2419	R	0.032	0.791
Galerida cristata	1571	M	0.028	0.785
Hirundo rustica	5551	M	0.017	0.679
Luscinia megarhynchos	4473	M	0.011	0.626
Cisticola juncidis	1898	M	0.018	0.682
Oriolus oriolus	1556	M	0.006	0.570
Pica pica	3826	M	0.021	0.720
Passer domesticus italiae	7180	M	0.021	0.729
Passer montanus	2606	M	0.020	0.708
Carduelis carduelis	5681	M	0.010	0.619
Anthus campestris	278	C	0.028	0.848
Anthus trivialis	561	C	0.050	0.665
Anthus spinoletta	403	C	0.055	0.901
Motacilla alba	1529	C	0.013	0.591
Prunella modularis	390	C	0.031	0.731
Phoenicurus ochruros	878	C	0.034	0.764
Saxicola rubetra	138	C	0.035	0.872
Oenanthe oenanthe	352	C	0.034	0.858
Monticola saxatilis	54	C	0.035	0.820
Turdus torquatus	121	C	0.038	0.794
Turdus pilaris	195	C	0.030	0.717
Sylvia curruca	140	C	0.033	0.794
Sylvia borin	142	C	0.030	0.712
Lanius collurio	1069	C	0.019	0.625
Corvus corone corone	334	C	0.028	0.703
Carduelis flammea	145	C	0.031	0.789
Emberiza citrinella	327	C	0.041	0.774
Motacilla flava	934	D	0.043	0.860
Corvus corone cornix	6457	D	0.011	0.590
Streptopelia turtur	3347	E	0.009	0.561
Upupa epops	1165	E	0.014	0.610
Jynx torquilla	605	E	0.011	0.612
Passer hispaniolensis	1188	E	0.014	0.625
Serinus serinus	4708	E	0.017	0.657
Carduelis chloris	3945	E	0.010	0.595

The possibility of calculating an overall score at 'community' level by means of angular coefficient seems a good tool to discriminate subtle environmental transformations evaluating, in a simple and objective manner, the evolution towards 'less agricultural' communities, both at landscape scale, following for instance the expansion of forest vegetation, or at minor scale with the individuation of the effects due to modifications of crops or systematic removal of structural elements (e.g. tree rows). Indeed, these environmental changes might be tracked by the consequent decrease or disappearance of a specific component of bird community (see in this volume, Londi *et al*. *Assessing woodland ecological characters through a new objective bird community index*). A similar approach appears essential to identify and to assess the priorities for the conservation and management of complex environmental systems such as the Mediterranean agricultural ones.

The importance of elaborating community indices has been widely demonstrated (Canterbury *et al*. 2000, Gregory *et al*. 2005), since indices based on data of single species are usually unable to give a complete picture of the effects produced by environmental changes and to take into account the complexity of interacting factors (Morrison 1986, Landres *et al*. 1988).

REFERENCES

Benton TG, Bryant MD, Cole L, Crick HQP 2002. Linking agricultural practice to insect and bird populations: a historical study over tree decades. Journal of Applied Ecology 39: 673-687

Bouma J, Varallyay G, Batjes NH 1998. Principal land use changes anticipated in Europe. Agriculture, Ecosystems & Environment 67: 103-119.

Burfield I, Van Bommel F (eds.) 2004. Birds in Europe. Population estimates, trends and conservation status. BirdLife Conservation Series, no. 12. BirdLife International, Cambridge, pp. 374.

Büttner G *et al.* 1998. The European CORINE Land Cover Database, ISPRS Commission VII Symposium, Budapest, September 1-4, 1998. Proceedings, pp. 633-638.

Canterbury GE, Martin TE, Petit DR, Petit LJ, Bradford DF 2000. Bird communities and habitat as ecological indicators of forest condition in regional monitoring. Conservation Biology 14: 544-558.

Chamberlain DE, Fuller RJ, Bunce RGH, Duckworth JC, Shrubb M 2000. Changes in the abundance of farmland birds in relation to the timing of agriculture intensification in England and Wales. Journal of Applied Ecology 37: 771-788.

Chamberlain DE, Wilson JD, Fuller RJ 1999. A comparison of bird populations on organic and conventional farmland in southern Britain. Biological Conservation 88: 307-320.

Cody M. L. (ed.) 1985. Habitat selection in birds. Academic Press. London. pp. 558.

Davidson J, Lloyd R (eds.) 1977. Conservation and Agriculture. John Wiley & Sons, Chichester, New York, Brisbane, Toronto, pp. 252.

de la Concha I 2005. The Common Agricultural Policy and the role of Rural Development Programmes in the conservation of steppe birds. In Bota G, Morales MB, Mañosa S, Camprodon J (eds.). Ecology and conservation of steppe-land birds. Lynx Edicions & Centre Tecnològic Forestal de Catalunya, Barcellona. pp. 141-168.

Diamond AW, Filion F (eds.) 1987. The Value of Birds. International Council for Bird Preservation. Technical Publication No. 6. Cambridge. pp. 268.

Draper NR, Smith H 1998. Applied regression analysis. Third edition. John Wiley & Sons, New York, pp. 706.

Fornasari L, De Carli E, Brambilla S, Buvoli L, Maritan E, Mingozzi T 2002. Distribuzione dell'avifauna nidificante in Italia: primo bollettino del progetto di monitoraggio MITO2000. Avocetta 26: 59-115.

Fornasari L, De Carli E, Buvoli L, Mingozzi R, Pedrini P, La Gioia G, Ceccarelli P, Tellini Florenzano G, Velatta F, Caliendo MF, Santolini R, Brichetti P 2004. Secondo bollettino del progetto MITO 2000: valutazioni metodologiche per il calcolo delle variazioni interannuali. Avocetta 28: 59-71.

Fuller RJ 1995. Bird Life of Woodland and Forest. Cambridge University Press. Cambridge.

Fuller RJ 2000. Relationships between recent changes in lowland British agriculture and farmland bird population. In: Aebischer NJ, Evans AD, Grice PV, Vickery JA (eds). Ecology and Conservation of lowland Farmland Birds. British Ornithologists' Union, Tring, UK.

Gregory RD, van Strien A, Vorisek P, Meyling AWG, Noble DG, Foppen RPB, Gibbons DW 2005. Developing indicators for European birds. Philosophical transactions of the Royal Society 360: 269-288.

Heldbjerg H 2004. Using population indices as biodiversity indicators - the importance of choosing the right species. Book of abstracts of the 16th International Conference of the European Bird Census Council. Birds numbers 2004. Monitoring in a changing Europe, 6th-11th of September 2004, Kayseri, Turkey.

Hosmer DW, Lemeshow S 1989. Applied logistic regression. J. Wiley & Sons, New York.

Julliard R, Levrel H, Jiguet F, Couvet D, Loïs G 2004. Multi-species, habitat-specific biodiversity indicators: the importance of species selection procedure. Book of abstracts of the 16th International Conference of the European Bird Census Council. Birds numbers 2004. Monitoring in a changing Europe, 6th-11th of September 2004, Kayseri, Turkey.

Koskimies P, Väisänen RA 1991. Monitoring bird populations. Zoological Museum, Finnish Museum of Natural History. Helsinki. pp. 144.

Krebs JR, Wilson JD, Bradbury RM, Siriwardena GM 1999. The second silent spring? Nature 400: 611-612.

Landres PB, Verner J, Thomas JW 1988. Ecological use of vertebrate indicator species: a critique. Conservation Biology 2: 316-328.

Manel S. Williams HC, Ormerod SJ 2001. Evaluating presence-absence models in ecology: the need to account for prevalence. Journal of Applied Ecology 38: 921-931.

Mcquarrie ADR, Tsai C.-L 1998. Regression and time series model selection. World Scientific Publishing Company, Singapore.

Meeus JHA, Wijermans MP, Vroom MJ 1990. Agricultural landscapes in Europe and their transformation. Landscape and Urban Planning 18: 289-352.

Morrison ML 1986. Bird populations as indicators of environmental change. Current Ornithology 3: 429-451.

Nanni P (ed.) 2002. Storia dell'agricoltura italiana. Accademia dei Georgofili, Edizioni Polistampa, Firenze, 5 voll.

Oñate JJ 2005. A reformed CAP? Opportunities and threats for the conservation of steppe-birds and the agri-environment. In Bota G, Morales MB, Mañosa S, Camprodon J (eds.). Ecology and conservation of steppe-land birds. Lynx Edicions & Centre Tecnològic Forestal de Catalunya, Barcellona. pp. 141-168.

Redecker B, Hardtle W, Finck P, Riecken U, Schroder E 2002. Pasture Landscapes and Nature Conservation. Springer Verlag, Berlin, pp. 435.

Robinson RA, Sutherland WJ 2002. Post-war changes in arable farming and biodiversity in Great Britain. Journal of Applied Ecology 39: 157-176.

Sanderson FJ, Donald PF, Burfield IJ 2005. Farmland birds in Europe: from policy change to population decline and back again. In Bota G, Morales MB, Mañosa S, Camprodon J (eds.). Ecology and conservation of steppe-land birds. Lynx Edicions & Centre Tecnològic Forestal de Catalunya, Barcellona. pp. 141-168.

Santos CP 2000. Succession of breeding bird communities after the abandonment of agricultural fields in south-east Portugal. Ardeola 47: 171-181.

Sauberer N, Zulka KP, Abensperg-Traun M, Berg H.-M, Bieringer G, Milasowsky N, Moser D, Plutzar C, Pollheimer M, Storch C, Troestl R, Zechmeister H, Grabherr G 2004. Surrogate taxa for biodiversity in agricultural landscapes of eastern Austria. Biological Conservation 117: 181-190.

Stoate C 1996. The changing face of lowland farming and wildlife. II. 1945-1995. British Wildlife 7: 162-172.

Van Strien A 2004. Indicators for the state of the Nature. Book of abstracts of the 16th International Conference of the European Bird Census Council. Birds numbers 2004. Monitoring in a changing Europe, 6th-11th of September 2004, Kayseri, Turkey.

Van Strien AJ, Pannekoek J, Gibbons DW 2001. Indexing European bird population trends using results of national monitoring schemes: a trial of a new method. Bird Study 48: 200-213 Tellini Florenzano G 2004. Birds as indicators of recent environmental changes in the Appennines (Foreste Casentinesi National Park, central Italy). Italian Journal of Zoology 71: 317-324.

Tucker GM 1997. Priorities for bird conservation in Europe: the importance of the farmed landscape. In: Pain DJ, Pienkowski MW (Eds.) Farming and Birds in Europe: the Common Agricultural Policy and its Implications for Bird Conservation. Academic Press, London, pp. 79-116.

Tucker GM 1999. Measuring the impacts of agriculture on biodiversity. pp. 89-104. In: Brouwer, F. & Crabtree, B (eds). Environmental Indicators and Agricultural Policy - CABI Publishing., Wallingford, UK.

Tucker GM, Heath MF 1994. Birds in Europe. Their conservation status. Birdlife International, Cambridge, UK.

Wilson AM, Fuller RJ 2001. Bird population and environmental change. BTO Research Report No. 263. British Trust for Ornithology, The Nunnery, Thetford, Norfolk.


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