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Assessment of population trends of common breeding birds in Lombardy, Northern Italy, 1992-2007

L. BANI [1,2], D. MASSIMINO [1], V. ORIOLI [1], L. BOTTONI [1] and R. MASSA [1]

[1] *Dipartimento di Scienze dell'Ambiente e del Territorio, Università degli Studi di Milano-Bicocca, Piazza della Scienza 1, 20126 Milano, Italy*

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A knowledge of population trends is essential in order to assess the conservation status of a species and to develop practices to manage ecologically sustainable land use. However, monitoring programmes designed to assess trends are often not carried out due to their high operating costs. Therefore, in order to obtain population trend estimates without a specific monitoring programme, it is necessary to use heterogeneous historical information. The aim of this research was to assess population indices and trends between 1992 and 2007 for common bird species breeding in Lombardy (Italy), applying a previously developed method, which permits data derived from different survey projects to be utilised. Among the 51 species considered, there were seven negative and 10 positive trends, whereas the remaining species did not show a significant population change. Major declines regarded farmland species, namely the Red-backed Shrike *Lanius collurio* and the Sky Lark *Alauda arvensis* which, over a 15 year period, decreased by more than 70%. Among forest species, the Common Chiffchaff *Phylloscopus collybita* declined, whereas the others either increased or did not demonstrate a significant trend. The population index also highlighted recurring patterns of inter-annual changes in the populations of different species, suggesting that certain ecological processes may have an effect on the whole community. The general decline of farmland species, which is known to occur in many other European regions, suggests the need for specific monitoring schemes for birds and their habitats, in order to understand the effects of changes in agricultural practices and to be able to plan effective measures for bird conservation in productive areas.

KEY WORDS: bird trends, habitat suitability models, Lombardy, monitoring, point counts.

[2] Corresponding author (E-mail: luciano.bani@unimib.it).

INTRODUCTION

The increasing loss, degradation and fragmentation of natural habitats, which in Europe are especially due to urban sprawl and the transformation of agriculture practices, have led to serious declines and even the extinction of many animal and plant populations. Data obtained from monitoring programmes are fundamental as "early warnings" for population decline and to, therefore, establish priorities and needs to address this issue (Thomas & Martin 1996). These data are also essential to investigate the environmental processes that induce such population changes and consequently, to assess the effectiveness of management or restoration efforts on species or habitats (Marchant et al. 1990, Bart 2005).

Following the increasing concern regarding population declines in many European breeding bird species, efforts have been made in several countries (Vorisek & Marchant 2003) as well as on a continental scale (Pan-European Common Bird Monitoring, EBCC 2009) in order to estimate bird populations and their trends. Monitoring programmes have also been used to assess and to review the conservation status of all birds (Tucker & Heath 1994, BirdLife International 2004). However, in many countries, the available data are insufficient to assess population size and trends for most species (Tucker & Heath 1994). Data are often scarce, due to the high operating costs of monitoring programmes and the significant human resource requirement necessary to carry out surveys, which cover wide geographical areas and have long durations (Elzinga et al. 2001, Bart 2005). In Italy, monitoring projects have never been carried out for long periods, although a national long-term survey started in 2000 (Fornasari et al. 2002, 2004); others were initiated in the past, but were shortly abandoned thereafter (Fornasari et al. 1998, Vorisek & Marchant 2003). Nevertheless, in some regions including Lombardy, bird data have been collected for many years (from 1992 to 2007) for different projects (e.g. Fornasari et al. 1998, Massa et al. 2002).

In order to deal with the lack of a specific long-term monitoring programme in Italy, Massimino et al. (2008) developed a method to assess population trends, using historical data collected with the same survey technique but belonging to different projects with specific sampling schemes.

During our research, we used this method to evaluate population indices and trends for common bird species breeding in Lombardy.

MATERIALS AND METHODS

Study area

Lombardy is a 23,861 km^2 region located in Northern Italy. It is characterised by lowlands (47%), hills (13%) and mountains (40%). Predominant land uses are: agriculture (40.0%), forest (25.4%, of which 16.0% deciduous, 5.6% coniferous and 3.8% mixed) and urban and residential areas (12.6%) (Fig. 1). Four main sub-regions can be identified: (1) the Alps, whose peaks reach 4000 m; (2) the pre-Alps, separated from the

Fig. 1. — Location of Lombardy (study area) in Italy.

Alps by a wide glacial valley (Valtellina); (3) the Po Valley; and (4) a small portion of the northern Apennine Mountains located in the south-western corner of the region. The Alps and the pre-Alps are characterized by coniferous forests and rangelands at high elevations and deciduous forests at lower ones. The Apennine area is characterized by vineyards, extensive farming and forests, which are mainly deciduous and mixed. The Po Valley is highly developed; intensive cereal cultivations predominate in the central and eastern part of the lowlands, whereas urban areas and rice fields prevail in the West. The region can be considered representative for assessing the conservation status of most farmland species breeding in Italy, as it includes about a quarter (more than 11,000 km^2) of the Po Valley, the largest Italian plain.

Faunal and environmental data

All bird data used for this research were collected using the point count technique (at unlimited distance and 10 min duration), performed during the breeding season (10th May-20th June) from sunrise to 11.00 hr, in good weather conditions (sunny to cloudy, without rain or strong winds) (Blondel et al. 1981, Fornasari et al. 1998). This technique provides a measure of relative bird abundance (Blondel et al. 1970, Bibby et al. 2000). All counts were expressed in number of pairs, according to the method described by Blondel et al. (1981). The minimum distance between sampling locations was at least 1000 m. The point count technique allows useful data to be collected for several bird species pertaining to Columbiformes, Cuculiformes, Apodiformes, Coraciiformes, Piciformes and Passeriformes, except for those that have localised habitats. The technique can also be used to survey some other common species, such as the Common Buzzard *Buteo buteo* and Common Kestrel *Falco tinnunculus*.

Data were collected from 1992 to 2007 by the same census team, consisting of two to eight persons, in six different projects using different sampling designs (Table 1). In 1992, a Long-Term Monitoring Program Pilot Project was launched; however, in 1995 the project was subject to unreliable resource availability and consequently, was interrupted after 1996 and further resumed in 2005. Data for this project were collected using a stratified sampling scheme, according to the different landscapes in the region. The census team carried out both a Forest Biodiversity Survey (1995-2004) and a Lowland Biodiver-

Table 1.

Number of bird point counts performed in each project in Lombardy and used for the estimation of the population index. No data are available for 1993, 1994, 1997 and 1998.

Project name	1992	1995	1996	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
Long-Term Monitoring Program Pilot Project	387												387
Long-term monitoring program		295	284							468	438	731	2216
Forest Biodiversity Survey		105	187	1115	625	219	123	67	18				2459
Lowland Biodiversity Survey		195	240		297	348	44						1124
Regional Faunal Database					581	464	387	551	437	564			2984
Greenway Project							86	61					147
Total	387	595	711	1115	1503	1031	640	679	455	1032	438	731	9317

sity Survey (1995-2002) focusing on forest lands and agricultural landscapes, respectively. Furthermore, from 2000 to 2005, the regional administration commissioned the establishment of the Regional Faunal Database, whose data were collected with a stratified sampling design. Finally, from 2002 to 2003 the census team performed a bird survey using a systematic sampling scheme, for the Greenway Project, aimed to draw a greenway for the Lombardy Apennine. No data were available for 1993, 1994, 1997 and 1998.

All point counts were georeferenced (UTM 32N, European Datum 50). This allowed us to link faunal data with a land use digital map with 32 classes (DUSAF, Destinazione d'Uso dei Suoli Agricoli e Forestali [Classification of Agricultural and Forest Lands]; ERSAF 2002) and a Digital Elevation Model (DEM), both with 20-m ground resolution.

Statistical analysis

The bias due to different sampling schemes was corrected by defining a population index as the ratio between the number of observed and expected pairs in each point. To estimate the number of expected pairs, we developed a habitat suitability model for each species using a Generalized Linear Model (GLM) (McCulloch & Searle 2001, Quinn & Keough 2002) for the negative binomial or Poisson distributions (McCullagh & Nelder 1989). The choice between the two distributions was made by evaluating the over-dispersion by a likelihood ratio test (Cameron & Trivedi 1998). The dependent variables were the number of bird pairs counted at each point, while the independent variables derived from the land use map and DEM were selected by a stepwise process. Models were validated with a leave-more-out technique (cross-validation, Guisan & Thuiller 2005), randomly splitting the samples into four equal-sized subsets. (for further details see Massimino et al. 2008).

Habitat suitability (expressed as the number of pairs expected per point count) defined by the model allowed us to calculate the population index (the ratio between actual and expected pairs). The overall annual mean index was assessed, using only point counts that were suitable for the particular species analysed; thus avoiding very low suitability values in the denominator, which would give very high ratio values for rare cases where pairs were detected in non-suitable habitats. Points with the best suitability values were considered to be suitable when they contained 95% of all pairs counted.

In order to evaluate the significance of the variability of the mean population index over the years, we calculated bootstrap estimates of the 95% confidence intervals (Efron 1982).

The overall trend from 1992 to 2007 was assessed by fitting the annual population index to a growth model of a population that reproduces seasonally (geometric growth; see Gotelli 2001):

$$I_t = I_0(1+R)^t$$

where I_t is the population index at time t, I_0 is the population index at time 0 (year 1992 in our case) and R is the geometric rate of increase.

Since the annual population index is a mean calculated from several sample units (whose number varies each year), we used Weighted Least Squares regression (see Quinn & Keough 2002), where the weight variable is the inverse of the bootstrapped standard error of the population index in each year.

As multiple comparisons were performed, we used a Benjamini & Hochberg (1995) correction in order to control the false discovery rate without too much loss of power.

Population indices and trends were estimated for all species with mean annual frequency equal to or higher than 3%.

We also excluded species whose population is artificially maintained, such as the Common Quail *Coturnix coturnix*, Common Pheasant *Phasianus colchicus* and Rock Pigeon *Columba livia*.

RESULTS

Annual population indices and trends were estimated for 51 breeding bird species. According to the results of the likelihood ratio test, we chose a negative binomial distribution for all species except the Common Cuckoo *Cuculus canorus* and Blackcap *Sylvia atricapilla*, whose data were Poisson distributed. The GLMs accounted for between 7.7% and 84.6% of the null deviance (Table 2). Every year, the population index and the bootstrap estimate of its confidence intervals were calculated for each species (Fig. 2). The growth

Table 2.

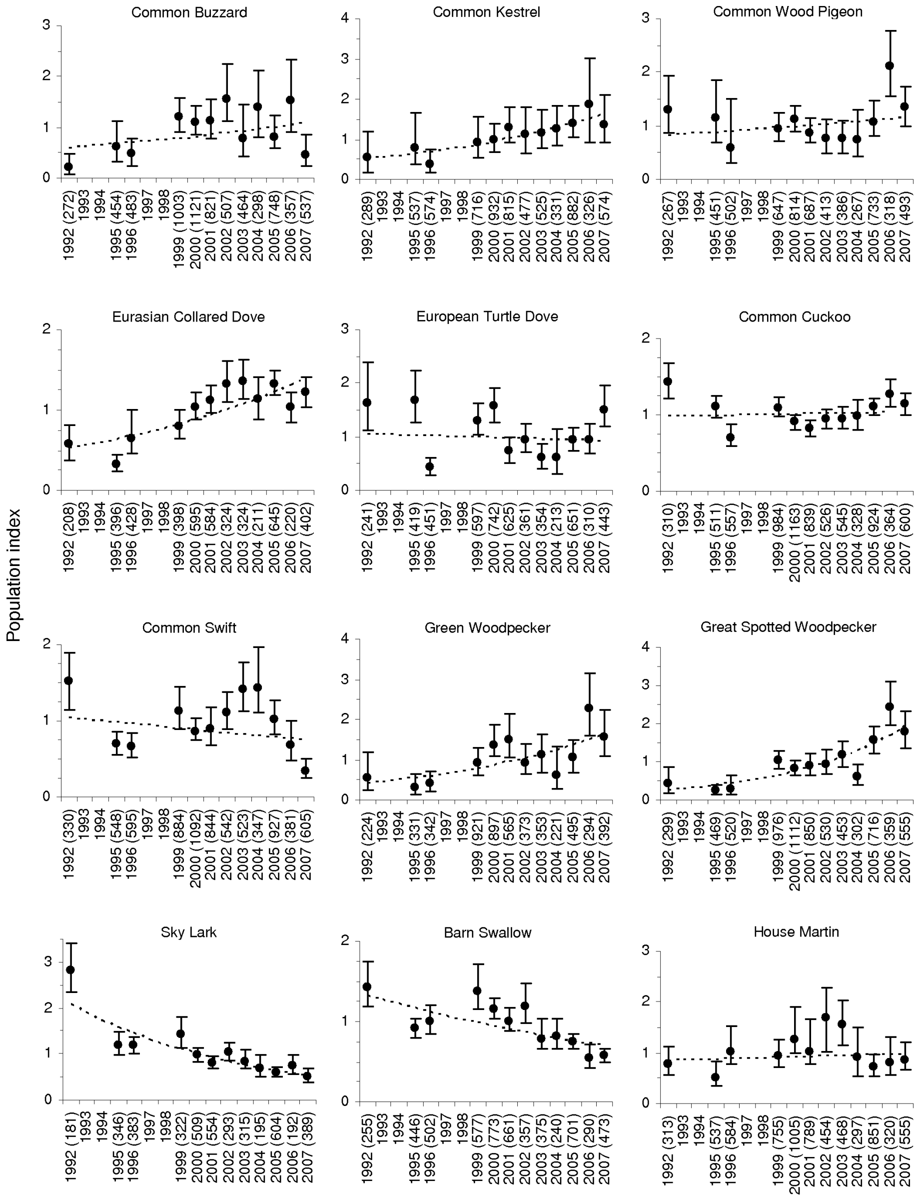
Percentage deviance explained by the habitat suitability models and parameters of the growth curve estimated for each species: *R*, geometric rate of increase; *P*, individual *P*-values for *R*; corrected *P*, corrected *P*-values according to BENJAMINI & HOCHBERG (1995); I_0, population index in 1992.

		Deviance explained by the model (%)	Deviance explained in validation (%)	R	*P*	Corrected *P*	I_0
Common Buzzard	*Buteo buteo*	10.4	7.4	0.041	0.244	0.376	0.586
Common Kestrel	*Falco tinnunculus*	11.7	8.7	0.082	0.001	0.009	0.497
Common Wood Pigeon	*Columba palumbus*	20.1	17.7	0.023	0.414	0.587	0.817
Eurasian Collared Dove	*Streptopelia decaocto*	39.7	39.2	0.068	0.004	0.026	0.517
European Turtle Dove	*Streptopelia turtur*	25.1	23.4	–0.008	0.810	0.826	1.038
Common Cuckoo	*Cuculus canorus*	13.2	12.3	0.004	0.775	0.806	0.974
Common Swift	*Apus apus*	7.7	6.0	–0.021	0.422	0.582	1.043
Green Woodpecker	*Picus viridis*	21.1	19.2	0.096	0.019	0.053	0.410
Great Spotted Woodpecker	*Dendrocopos major*	18.4	17.2	0.146	0.002	0.022	0.249
Sky Lark	*Alauda arvensis*	45.4	44.3	–0.088	<0.001	0.005	2.080
Barn Swallow	*Hirundo rustica*	32.7	31.0	–0.043	0.006	0.027	1.326
House Martin	*Delichon urbicum*	12.3	9.3	0.010	0.636	0.676	0.837
Tree Pipit	*Anthus trivialis*	63.4	59.9	0.094	0.004	0.025	0.452
Water Pipit	*Anthus spinoletta*	84.6	82.5	0.043	0.186	0.317	0.625
Yellow Wagtail	*Motacilla flava*	52.6	49.1	–0.013	0.344	0.502	1.143
Grey Wagtail	*Motacilla cinerea*	24.1	20.8	–0.046	0.050	0.101	1.257
White Wagtail	*Motacilla alba*	11.8	10.1	–0.027	0.047	0.104	1.222
Winter Wren	*Troglodytes troglodytes*	31.6	30.5	–0.018	0.168	0.295	1.200
Hedge Accentor	*Prunella modularis*	59.4	58.9	0.090	0.050	0.099	0.399

(*continued*)

Table 2. (*continued*)

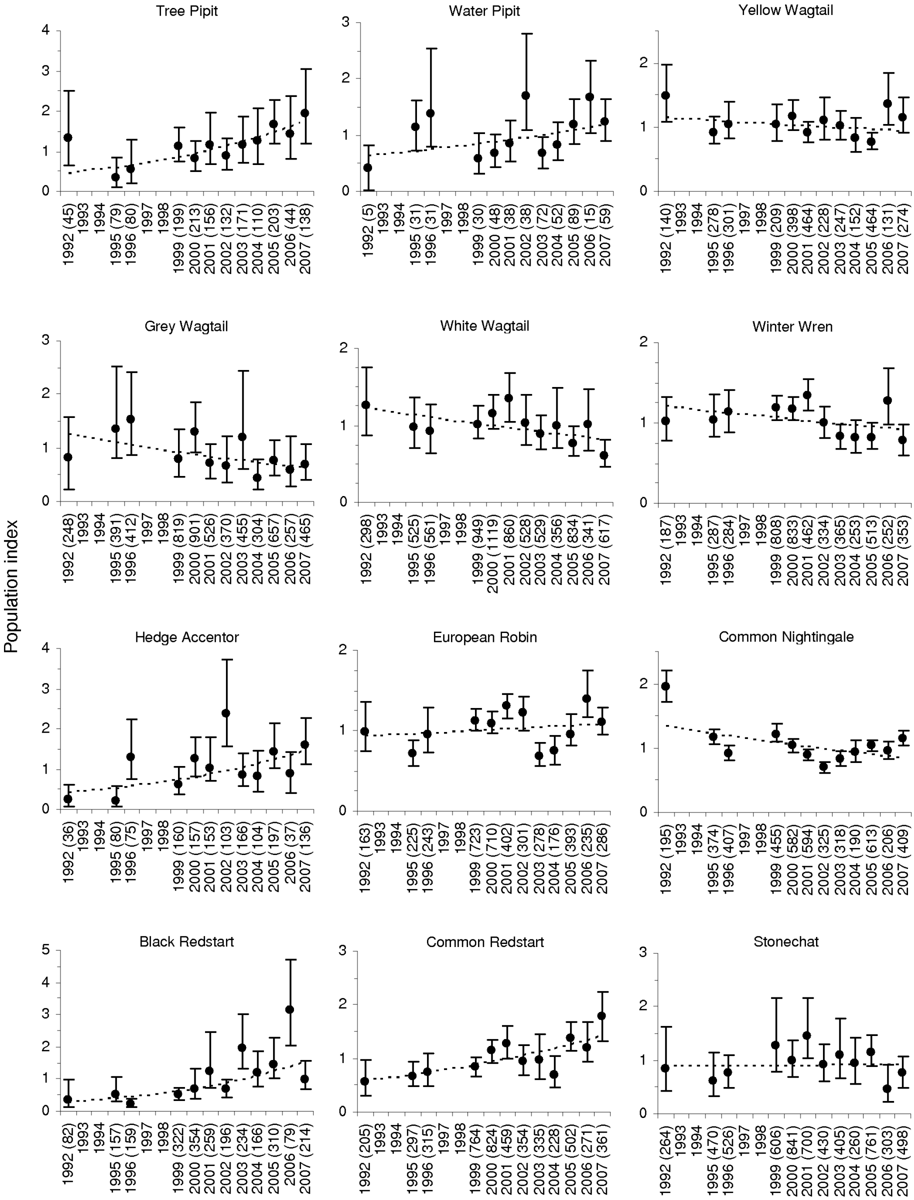
		Deviance explained by the model (%)	Deviance explained in validation (%)	R	*P*	Corrected *P*	I_0
European Robin	*Erithacus rubecula*	45.3	44.6	0.010	0.574	0.650	0.925
Common Nightingale	*Luscinia megarhynchos*	49.4	48.4	–0.030	0.075	0.141	1.332
Black Redstart	*Phoenicurus ochruros*	55.9	53.7	0.125	0.020	0.054	0.263
Common Redstart	*Phoenicurus phoenicurus*	28.1	23.0	0.062	0.007	0.027	0.575
Stonechat	*Saxicola torquata*	20.5	17.1	0.002	0.925	0.925	0.885
Common Blackbird	*Turdus merula*	22.2	21.3	–0.019	0.089	0.162	1.188
Song Thrush	*Turdus philomelos*	33.9	30.5	0.125	0.008	0.030	0.325
Cetti's Warbler	*Cettia cetti*	33.7	32.5	–0.018	0.567	0.657	1.007
Blackcap	*Sylvia atricapilla*	21.2	20.6	–0.003	0.616	0.683	1.051
Western Bonelli's Warbler	*Phylloscopus bonelli*	48.3	42.0	0.028	0.341	0.511	0.729
Common Chiffchaff	*Phylloscopus collybita*	43.9	42.7	–0.044	0.009	0.030	1.488
Goldcrest	*Regulus regulus*	55.8	54.0	–0.022	0.506	0.615	0.928
Spotted Flycatcher	*Muscicapa striata*	15.6	10.1	0.059	0.049	0.104	0.596
Long-tailed Tit	*Aegithalos caudatus*	20.1	17.4	0.070	0.011	0.033	0.557
Marsh Tit	*Poecile palustris*	42.6	39.5	0.138	0.005	0.026	0.294
Crested Tit	*Lophophanes cristatus*	51.3	48.1	0.030	0.555	0.658	0.483
Coal Tit	*Periparus ater*	60.1	59.0	0.013	0.433	0.566	0.910
Blue Tit	*Cyanistes caeruleus*	29.2	26.6	0.073	0.013	0.039	0.569
Great Tit	*Parus major*	15.7	14.6	0.034	0.046	0.106	0.767
Wood Nuthatch	*Sitta europaea*	34.9	33.0	0.035	0.433	0.580	0.595
Eurasian Golden Oriole	*Oriolus oriolus*	34.2	32.5	0.021	0.505	0.629	0.826
Red-backed Shrike	*Lanius collurio*	15.5	11.2	–0.105	0.002	0.020	2.311
Eurasian Jay	*Garrulus glandarius*	26.2	24.2	0.051	0.034	0.083	0.657
Black-billed Magpie	*Pica pica*	36.4	34.3	0.082	0.027	0.068	0.438
Hooded Crow	*Corvus cornix*	36.4	35.3	0.009	0.444	0.566	0.891
Common Starling	*Sturnus vulgaris*	42.5	39.6	0.012	0.622	0.675	0.825
Italian Sparrow	*Passer italiae*	36.1	34.6	–0.066	<0.001	0.008	1.618
Eurasian Tree Sparrow	*Passer montanus*	31.0	28.5	–0.030	0.243	0.388	1.226
Chaffinch	*Fringilla coelebs*	39.1	38.7	0.010	0.207	0.340	0.941
European Serin	*Serinus serinus*	24.9	23.4	0.064	0.003	0.024	0.588
European Greenfinch	*Carduelis chloris*	19.4	17.5	–0.060	0.001	0.009	1.523
European Goldfinch	*Carduelis carduelis*	12.6	10.4	–0.046	0.005	0.024	1.363



(continued)

Fig. 2. — Bird population index and bootstrap estimate of its 95% confidence interval. Dashed line indicates the trend fitted by the growth curve (see Table 2 for the significance of the geometric rate of increase *R*). Bracketed number is the sample size.

Fig. 2. — (*continued*)



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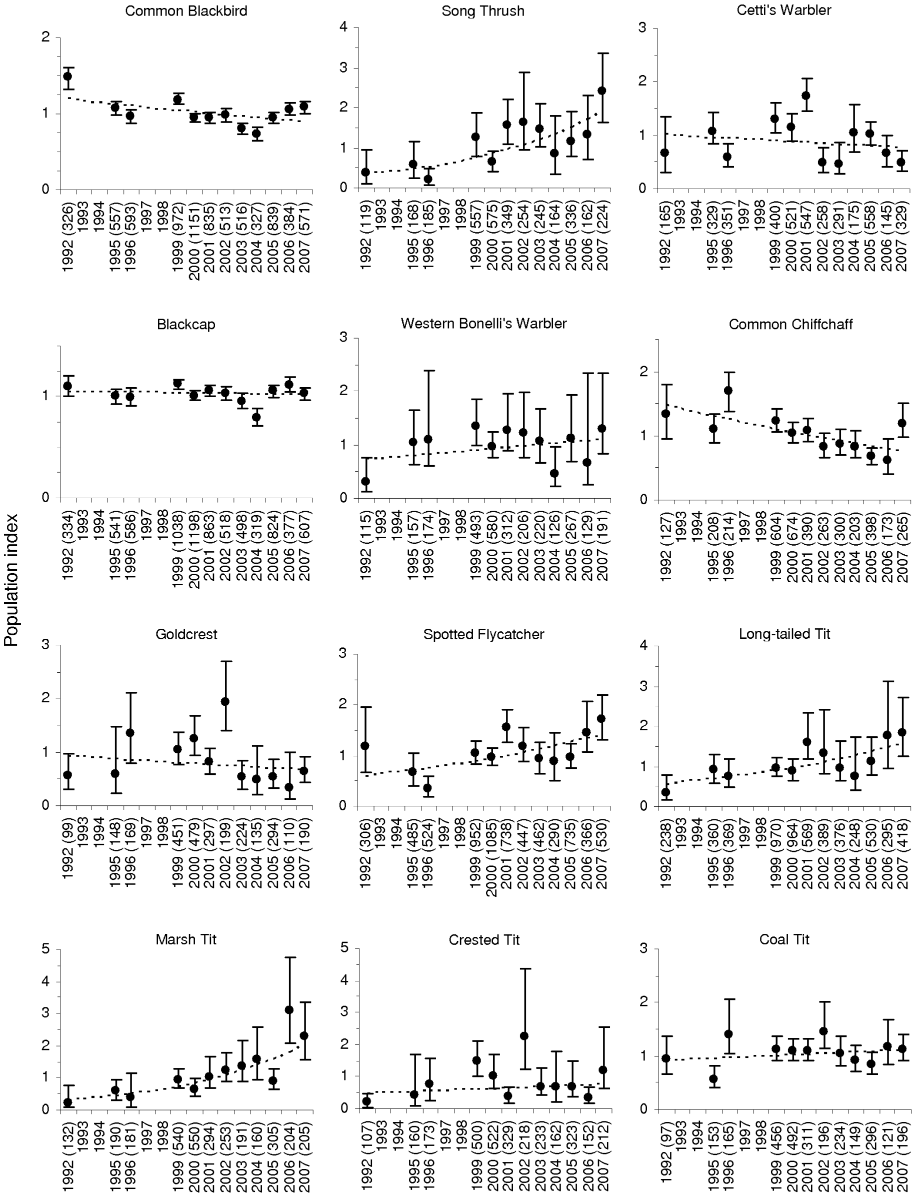

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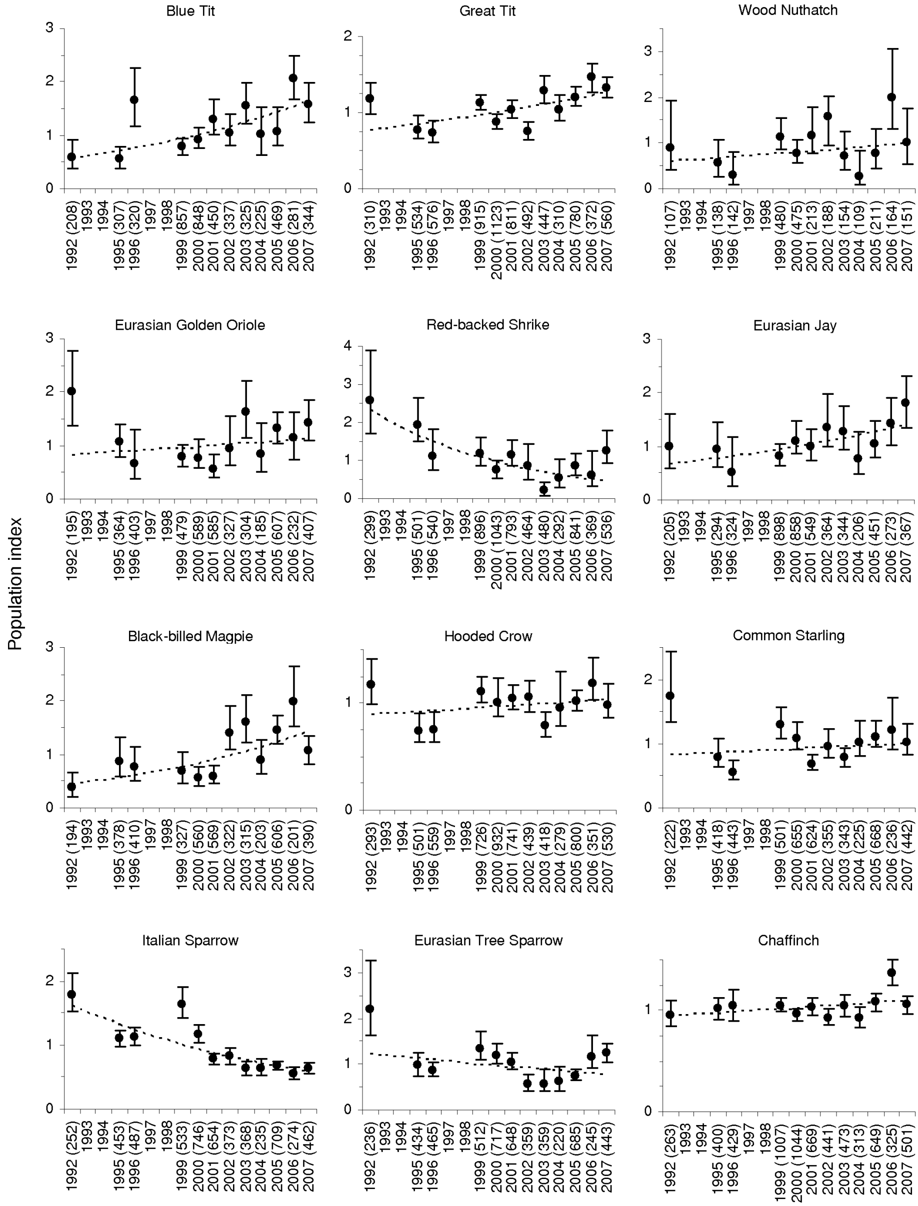

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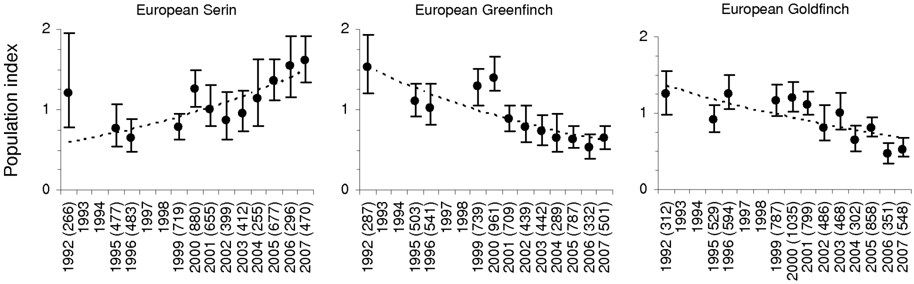

model used to evaluate the population trends between 1992 and 2007 gave an estimate of the geometric rate of increase *R*, which represents the annual percentage population increase or decrease for the whole period.

Seven species showed a significant (corrected $P < 0.05$) population decline (negative *R*): the Red-backed Shrike *Lanius collurio* (– 10.5%), Sky Lark *Alauda arvensis* (– 8.8%), Italian Sparrow *Passer italiae* (– 6.6%), European Greenfinch *Carduelis chloris* (– 6.0%), European Goldfinch *Carduelis carduelis* (– 4.6%), Common Chiffchaff *Phylloscopus collybita* (– 4.4%), and Barn Swallow *Hirundo rustica* (– 4.3%).

Ten species showed a significant population increase (positive *R*): the Great Spotted Woodpecker *Dendrocopos major* (14.6%), Marsh Tit *Poecile palustris* (13.8%), Song Thrush *Turdus philomelos* (12.5%), Tree Pipit *Anthus trivialis* (9.4%), Common Kestrel (8.2%), Blue Tit *Cyanistes caeruleus* (7.3%), Long-tailed Tit *Aegithalos caudatus* (7.0%), Eurasian Collared Dove *Streptopelia decaocto* (6.8%), European Serin *Serinus serinus* (6.4%), and Common Redstart *Phoenicurus phoenicurus* (6.2%).

DISCUSSION

During our research we analysed the population trends of common birds that breed in Lombardy, by means of a population index that allowed us to use heterogeneous census data, collected with different sampling schemes.

The rather low deviance explained by the habitat suitability model for some species (e.g. the Common Buzzard, Common Kestrel, Common Cuckoo, Common Swift *Apus apus*, House Martin *Delichon urbicum*, White Wagtail *Motacilla alba* and European Goldfinch) may be due to their low selectivity for the environmental variables considered in the model.

Some species, such as the Water Pipit *Anthus spinoletta*, Grey Wagtail *Motacilla cinerea*, Western Bonelli's Warbler *Phylloscopus bonelli* and Wood Nuthatch *Sitta europaea*, exhibited rather large confidence intervals for their population indices. This may be due to their ecological specificity, which implies limited diffusion of their habitat and, therefore, low sample size (few point counts fell in suitable areas) or to their low density, which causes high variance within the sample. In the case of the Wood Nuthatch, a species rather widespread on woodlands in Northern Italy, the possible reason may be its selectivity for environmental variables not considered in the model, such as the forest structure (BANI et al. 2006) and its floristic composition (MATTHYSEN 1987).

For rarer species, whose population index could not be ascertained during this research, a larger sample should be collected, possibly identifying more suitable habitats using the habitat suitability model (THOMPSON 2004, GUISAN et al. 2006).

Our study allowed us to highlight the decline of several breeding birds. The most dramatic declines were observed for the Red-backed Shrike and the Sky Lark with population declines of 81% and 75%, respectively (as calculated by the growth model over 15 years). Similar trends were also recorded for these species in other European countries: between 1970 and 1990 the Sky Lark showed a decline greater than 50% in the United Kingdom, the Netherlands and Germany; whereas the Red-backed Shrike decreased to a lesser extent, yet still greater than 20% for more than half of the European population (TUCKER & HEATH 1994). In the 1990s, the decline of these species, although slowed in many parts of their distributional range, continued in most European countries (BIRDLIFE INTERNATIONAL 2004, DONALD et al. 2006). Major causes are likely to be related to habitat modifications due to the intensification of agricultural practices (see NEWTON 2004 for a detailed review on the causes and mechanisms of farmland bird population declines). In particular, the Sky Lark is sensitive to the reduction of crop diversity and rotational cropping, increase of autumn ploughing and sowing, the massive usage of fertilisers and pesticides and grazing intensity (GREEN 1978, O'CONNOR & SHRUBB 1989, WILSON et al. 1997, DE CARLI et al. 1998, ROBINSON 2001, DONALD et al. 2002, DONALD 2004, LAIOLO et al. 2004, BÁLDI et al. 2005), while the Red-backed Shrike also suffers from the reduction or removal of hedgerows, shrubs and old grassland habitats (LEFRANC 1997, TUCKER & EVANS 1997, SHRUBB 2003). It is likely that agricultural intensification plays an important role in northern Italy and in Lombardy as well: cereal yield for example, which is considered a good index of agricultural intensity (DONALD et al. 2006), was 10.0 *t* ha^{-1} in Lombardy in 2005 (ISTAT 2007), higher than the average value of any European country, except Austria (FAO 2007).

Other birds that showed large declines between 1992 and 2007 were also farmland species: Italian Sparrow (– 64%), European Greenfinch (– 61%), European Goldfinch (– 51%) and Barn Swallow (– 48%). The Barn Swallow and House Sparrow *Passer domesticus*, which is vicarious of the Italian Sparrow, are also decreasing on a continental scale (ROBINSON et al. 2005, PAZDEROVÁ & VORISEK 2007). There is much evidence that agricultural intensification has been a major cause of the decline of these two species also. In particular, the Barn Swallow suffered from the loss of pastures (EVANS et al. 2007) and the decline of the number of livestock farms (AMBROSINI et al. 2002), with consequent reduction in the numbers of aerial insects, apart from changes in the climate or other conditions in wintering areas that also can affect migrant birds (SANDERSON et al. 2006). The House Sparrow mainly suffered from reduction in winter food supply due to agricultural intensification (HOLE et al. 2002). The decline of the Italian Sparrow in Lombardy is confirmed in a recent study by BRICHETTI et al. (2008) who estimated a decrease of 50% of the urban breeding population between 1996 and 2006. The European Greenfinch is mainly considered stable throughout Europe, although it is decreasing in France, which hosts the largest European population (BirdLife International 2004). The European Goldfinch is instead assessed as increasing (Donald et al. 2006), but we note that for most Mediterranean countries, where the majority of its European populations lives, trends are poorly known and quantitative data are not available (BirdLife International 2004).

It is important to consider the risks connected with falsely accepting null hypotheses, which could lead us to ignore species with an unfavourable conservation status. For this reason, attention should be paid to species that show a perceptibly (although not statistically significant) negative R or maintain a low population level after a marked fall. The White Wagtail is suspected to have declined in our study area (R = – 0.027, corrected P = 0.104) and on a continental scale (Pazderová & Vorisek 2007). The Common Nightingale *Luscinia megarhynchos*, Common Starling *Sturnus vulgaris* and Eurasian Tree Sparrow *Passer montanus* all showed significant large declines between 1992 and 1995, followed by partial recoveries in 1999 followed by a further decline and recovery. While the Eurasian Tree Sparrow suffered declines in several European countries during the last decade of the past century, the Common Nightingale is considered stable overall in Europe (BirdLife International 2004), although it is decreasing in France (Jiguet et al. 2006), which hosts one of the major populations in the continent.

Another suspected declining species is the Grey Wagtail, whose main habitat requirement is a combination of fast-running streams, rocks, sheltering trees and holes for nesting (Snow & Perrins 1997). It is difficult to formulate hypotheses for its negative trend in our study area. This species is considered in moderate decline in Europe (Pazderová & Vorisek 2007), and has been amber-listed (as a species of medium conservation concern) in the United Kingdom (Gregory et al. 2002).

Among forest species, only the Common Chiffchaff declined significantly, as recorded in some other European countries, including France where the main European population breeds (Jiguet et al. 2006). All other forest species either increased or did not exhibit significant trends. This is in contrast to what happened on a continental scale, where common forest birds had, on average, a decline in number in the last two decades of the past century (Gregory et al. 2007). The observed increase of species, sensitive to woodland structure, may be partially explained by a reduced timber harvest in our study area, which allowed forest maturity to increase (RSY of Lombardia 2005).

Attention should be paid to the positive trend showed by nest predators such as the Black-billed Magpie *Pica pica* and Eurasian Jay *Garrulus glandarius* for their effect on the nesting success of small passerines (Batári & Báldi 2004), although the influence on prey populations still remains disputed (Chiron & Julliard 2007).

The method applied here also allowed us to highlight several patterns of inter-annual fluctuations in the population index that recurred in different species. Similar patterns occurring both in resident and in long-distance migrant species may be explained by processes that act during the breeding season. Several species that breed in agricultural or open landscapes, such as the Sky Lark, Common Starling, Italian Sparrow, Eurasian Tree Sparrow, European Greenfinch (short-distant migrant or resident species), Barn Swallow and Common Nightingale (trans-Saharan migrants), showed a clear decrease between 1992 and 1995-1996, followed by a partial recovery in 1999.

For some trans-Saharan species, such as the European Turtle Dove *Streptopelia turtur*, Common Cuckoo, Common Nightingale and Spotted Flycatcher *Muscicapa striata* there was a critical year in 1996, when their populations were clearly lower than those expected from the long-term trend. This is possibly due to events that occurred in Africa during their wintering season or migration. Moreover, both the European Turtle Dove and Common Nightingale declined between 1992 and the beginning of the new century but recovered in subsequent years. The former species was also assessed as decreasing at a continental scale as several other Afro-Palearctic migrants (SANDERSON et al. 2006).

With respect to three other groups, different patterns were observed: the population index of the Common Blackbird *Turdus merula* and the Blackcap, generalist species that share a large part of their breeding habitats, showed two positive (in 1999 and 2006) and a negative (in 2003-2004) peaks relative to their fitted trend line. Meanwhile, both the Green Woodpecker *Picus viridis* and the Great Spotted Woodpecker showed a low population index at the beginning of the surveyed period and a very high positive peak in 2006. Finally, the Great Tit *Parus major* and the Chaffinch *Fringilla coelebs*, which also have a broad niche overlap, displayed regular inter-annual fluctuations.

Patterns that recur in several species may be due to inter-annual meteorological variability. Considering the effects of stochastic fluctuations on threatened species, research to understand the effects of weather conditions on bird populations in Lombardy should be undertaken.

The general decline of farmland species suggests the need for specific monitoring schemes for both the birds and their habitats, to permit an improved understanding of the role of changes in agricultural practices and, more generally, land management on such declines. These changes may be very important to determine variations in carrying capacity, even without an apparent land use transformation. In our study area, for example, percentage changes in urban, agricultural and forest areas were less than 3% between 1992 and 2005 (ARPA 2002, 2006).

Information derived from bird monitoring programmes and habitat surveys is essential for the identification of effective bird conservation measures in productive areas, such as farmland landscapes (PAIN & PIENKOWSKI 1997).

Given the importance of knowing population trends and their drivers, we consider that when economic resources for monitoring are discontinuously available, it is important to collect unbiased samples at least in some years and to use such samples and all other available data for trend estimation. Data from unbiased samples will be extremely useful to validate population indices calculated by the use of all available data.

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