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Population trends of common breeding and wintering birds in Hungary, decline of long-distance migrant and farmland birds during 1999–2012

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Abstract Based on the Hungarian common bird monitoring scheme (MMM), which is the longest running country-wide monitoring using formal sampling design with representative data for the main habitats in Central-Eastern Europe, we investigated the population trends of common breeding and wintering species. Habitat preference and occupancy of the common breeders, migration strategies and relationships among these characteristics could act behind the population trends. We pointed out that long distance migrant bird species had strong decreasing trends in Hungary and very probably in the entire Pannonian biogeographical region, whereas the partial and short migrant species has increasing trends. Farmland birds had declining trend, which trend became more obvious since the joining of Hungary to the EU. The negative changes in the farmland habitat could influence bird species nesting/foraging mainly in this habitat independently from their migration strategies. Our investigations let us to develop indicators on the basis of migration strategy and habitat usage of common birds to provide regular information about condition of groups of species and their habitats in Hungary and the Pannonian region. The MMM database provide unique opportunity for further investigations of several species, habitats and area specific in a part of Europe where this kind of information is rare yet.

Keywords: monitoring, Pannonian region, biodiversity indicators, Farmland Bird Indicator (FBI), climate change, migration strategies, habitat preference and occupancy

Összefoglalás A Mindennapi Madaraink Monitoringja (MMM) a leghosszabb ideje futó országos léptékű olyan monitorozó program Közép-, Kelet-Európában, amely random mintavételi stratégia alkalmazásával reprezentatív adatokkal szolgál a régió madárállományairól és főbb élőhelyeiről. Munkánkban a gyakori fészkelő és telelő fajok állomány trendjeit, a gyakori fészkelők élőhely preferenciáját és használatát, valamint vonulási stratégiáját vizsgáltuk az állományváltozások hátterében zajló folyamatok feltárása érdekében. Kimutattuk, hogy a hosszútávon vonuló madárfajok esetében jelentős állománycsökkenés van Magyarországon és feltehetően az egész Pannon biogeográfiai régióban. Ugyanakkor a részlegesen és rövidtávon vonuló madárfajoknál növekedő állomány a jellemző. A mezőgazdasági élőhelyekhez kötődő fajoknál csökkenő állományok vannak, amely jelleg különösen Magyarország EU tagsága után erősödött fel. A mezőgazdasági élőhelyeken zajló kedvezőtlen változások az ott fészkelő/táplálkozó madárfajok helyzetét jelentősen befolyásolhatják e fajok vonulási stratégiájától függetlenül. Vizsgálatunk lehetőséget ad a gyakori madárfajok vonulási és élőhelyi jellemzőin alapuló olyan indikátorok fejlesztésére, amelyek rendszeres információval szolgálnak adott fajcsoportok és az azok által használt élőhelyek állapotáról Magyarországon és a Pannon régióban. Az MMM adatbázis egyedülálló lehetőséget ad nagyszámú faj, élőhely és terület további részletes vizsgálatára Európa olyan részén, ahol ezen információk még igen ritkák napjainkban.

Kulcsszavak: monitorozás, Pannon régió, biodiverzitás indikátor, Mezőgazdasági Élőhelyek Indikátora (FBI), klímaváltozás, vonulási stratégia, élőhely preferencia és használat

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Introduction

Biodiversity in Europe showed large changes during the last decades, most of these changes could cause unprecedented loss without effective conservation action based on adequate information about condition of biodiversity (Balmford *et al*. 2003). Biodiversity monitoring schemes with relevant design in relation to the questions they want to answer, to the progress they want to follow, and to the taxa and scales they want to investigate are key for having proper information (Yoccoz *et al.* 2001). Monitoring of common birds species using random sampling design at national, regional and continental levels is one of the most proper biodiversity monitoring approach which could provide important information about such essential questions as the influence of habitat loss and degradation, farming practices and climate change on size and distribution of numerous bird species and on the ecological system they belong to (Gregory *et al.* 2005, Jiguet *et al.* 2012). The birds are very proper taxa for monitoring because of the large and extended network of observers, the national and international NGOs for organising and scientifically coordinating all parts of the work (design, field work, database, analysis, cooperation with scientific communities), the scientific background nationally and internationally for analysing and interpreting the information and the large interest from the public towards these species (Greenwood 2007, Gregory & van Strien 2010).

Following the success of the Breeding Bird Survey (BBS) started in 1994 in the UK, (Gregory *et al.* 1996) which was the first national common bird monitoring scheme in Europe using random sampling design, the European Bird Census Council (EBCC) started to initiate similar schemes in several other European countries to form Pan-European Common Bird Monitoring Schemes (PECBMS) based on common birds at the end of the 20th century (Gibbons 2000). The EBCC invited the MME/BirdLife Hungary in 1997 to start a new country-wide common breeding bird monitoring scheme in Hungary based on a formal design (Szép & Gibbons 2000).

After the first pilot year in 1998, when the concept of the random sampling design and field protocol was tested with contribution of more than hundred observers and experts of the EBCC, the new scheme called Mindennapi Madaraink Monitoringja (MMM – Monitoring of Common Birds) has started with the final, existing protocol in 1999 as the first common bird monitoring scheme in Central and Eastern Europe using random sampling design and collecting representative data on the level of country (Szép & Gibbons 2000). The MMM scheme is able to monitor not only the breeding population in Hungary but by using the same field protocol data is collected from wintering populations of common bird species since 2000 (Szép & Nagy 2002).

A number of monitoring schemes already existed in Hungary before the start of the MMM (Báldi *et al.* 1997), mostly organised and executed within the umbrella of MME/BirdLife Hungary: White Stork, *Ciconia ciconia*, surveys since 1958; waterfowl counts since 1974; surveys of rare birds of prey species since 1974; Actio Hungarica ringing programme since 1974; integrated population monitoring of breeding Sand Martins, *Riparia riparia*, along the river Tisza since 1986. A scheme to monitor rare and colonial birds (known by the acronym 'RTM') was started in 1992 and uses territory mapping within observer-chosen 2.5×2.5 km UTM squares (Szép & Waliczky 1993). Fieldwork

is undertaken by a hundred or so volunteers and is mostly concentrated within Important Bird Areas (IBAs). The first country-wide monitoring of common breeding birds using a standardised counting method was started only in 1988. This used the point count method to monitor breeding passerines, with a total of 20–40 areas covered annually by 20–50 participants (Waliczky 1991). Sites were selected by the observers and were mainly in forested areas. Because of the low level of participation, the bias towards forested habitats in relatively few geographical regions of Hungary and observer choice of sites, population trend data produced by this scheme cannot be taken as representative of trends for common breeding birds in Hungary as a whole.

The information provided for breeding and wintering common bird species by the MMM scheme in Hungary since 1999 using standard methods for trend analysis (TRIM, Pannekoek & van Strien 2001) has importance not only for Hungary but for large part of Central and Eastern part of Europe, covered by the countries of the former Eastern Bloc, many of them joined to the EU since in 2004. In most of those countries, monitoring of common birds, representative on the level of country has not or partly existed before 1999 and new monitoring schemes in these countries follow the PECBMS standard has started later then the MMM. The different geographic, climatic, economic, political and environmental conditions of these countries compared to former EU member countries makes it important to have proper database, compatible with existing databases in Europe for analysing the kind of effects e.g. as Common Agricultural Policy (CAP), Agri-Environment Schemes (AES) of EU (Butler *et al.* 2010) and climate change (Both *et al.* 2010).

Biodiversity indicators based on annual indices of common bird species related to specific habitat has an increasing importance in the World (Butchart *et al.* 2010) following the successful application of it in the European Union (Gregory & van Strien 2010). The farmland bird indicator (FBI) is the most widely used such multi-species indicator in Europe, which based on population trends of common bird species related to farmland habitat and indicates the adverse changes in this habitat in relation to the Common Agricultural Policy (CAP) in many EU countries (Gregory *et al.* 2005). Several countries and the EU are increasingly using these measures to assess sustainable development strategies, environmental and ecosystem health (Gregory & van Strien 2010).

The concept developed by Gregory *et al.* (2003, 2005) let to consider more indicators for other habitats or group of species when relevant classification of species available based on quantitative data and/or expert judgement guided by additional information. The classification of species to a specific habitat generally could be proper for most of the species in each region and country in Europe, however in the case of some species marked differences exist among regions and countries because of natural and human related (e.g. different farming practices) reasons. The EBCC has recognised this problem and suggested different species for the main European biogeographical regions to calculate indicators for farmland, forest and others habitat types nationally, regionally and continentally (http://www.ebcc.info) (Gregory & van Strien 2010), based on Tucker and Evans (1997) and on experts (invited from most of the European countries) judgement. The common bird monitoring schemes with random sampling design can

make it possible to use quantitative approaches to classify species to specific habitats depending on the available habitat information (Julliard *et al.* 2003, 2006).

In Hungary, country-wide habitat survey was carried out in the frame of the CORINE land cover program between 1998–2003 producing a high resolution 1:50 000 GIS database (Büttner & Maucha 2006), which coincided with the start of the MMM scheme where locations of field observations are in a GIS database. These databases allow us to investigate the habitat preference and habitat occupancy of the common bird species at the level of landscape and to verify existing classification for the Hungarian populations of these species and developing further indicators considering habitat and migration strategies of the breeding species based on ringing data (Csörgő *et al.* 2009).

Our aim in this paper to provide an overview of the main characteristics of the Hungarian common bird monitoring scheme (MMM), from the sampling design, monitoring protocol until the trend estimation. We aim to provide information about the frequency and trends of bird species observed during the breeding and wintering season in Hungary. Based on the MMM database with combination of existing CORINE land cover GIS data, we overview the habitat occupancy and preference of the common breeding bird species in Hungary, considering the four main habitat types (urban, farmland, forest, wetland) which provide option to develop relevant habitat related indicators in this region. We investigate differences in population trends between species groups with different habitat classification, occupancy and preference and with different migration strategies.

Material and Methods

The Hungarian common bird monitoring scheme (MMM) is based on point count in grid cells with semi-random sampling design. The surveyed sites are 2.5×2.5 km UTM squares (Universal Transverse Mercator geographic coordinate system), randomly selected for each observer within a minimum of 10 km radius area around a locality specified by the observer. Observers carried out 5 minute long point counts at 15 points, randomly selected from the 25 potential points within the 2.5×2.5 km UTM squares, where points were separated by 500 m. The staff of the MMM scheme send high resolution map (1:15 000) of the selected 2.5×2.5 km UTM squares which contains position and 50, 100 m radius area of the 25 points within the squares. Coordinates of the UTM square and 25 points in a GoogleEarth format are available for the observers on the MMM website (mmm.mme.hu). Selection of the points within the UTM squares done in the first year of the selection of the UTM squares. In the first year the observers received a list of the 15 selected points (using latin square approach) from the staff of the MMM, which they must survey within the UTM squares. The observers could change some points to another one only in the case of specific situation (closed area, very difficult to reach by e.g. river, highway etc.) using a random list of points to change the formerly suggested to another one. The points which were selected and surveyed in the first year investigated during the following years. Each year, the observers asked to draw a simple map for the 100 m radius area of each point in a specific field book to show the different habitat patches, using Hungarian habitat classification codes (Á-NÉR; Fekete *et al.* 1997). During the five minute counts the observers asked to

indicate in the field book the distance of the observed birds using 0–50, 51–100, 100–200 m distance categories and a separate category for birds flied over the 100 m radius area of the points.

Survey of the breeding population happen twice per spring with minimum 2 weeks between sampling sessions from mid April to mid June since 1999. The count at the selected points took place between 5 and 10 am, when wind speed is less then 5m/s and there is no rain. Survey of the wintering population happen once in January since 2000. The count at the selected points took place between 6 and 16 hour, when wind speed is less then 5m/s and there is no raining/snowing. Time of the observation and wind speed (Beaufort scale) recorded at each point in the field book.

Observers asked to fill a form (which contains all bird species occurring in Hungary) after the field work in which form they indicated for each species their skill of identification of the species using four categories (by view, by sound, by view and sound, uncertain). This confidently handled database let us to consider the reason of absence of species in the surveyed 2.5×2.5 km UTM square, when large number of observers (~1000 observers) with various identification skills were contributed (Szép & Gibbons 2000).

For each species, we retained the maximum count per point for the two spring sessions and one count for the winter session. Counts were summed for the 15 points within each square for each year. Between 1999 and 2012, 15199 points in 984 pieces of 2.5×2.5 km UTM squares were surveyed during the breeding season by 762 observers. Between 2000–2012, 5768 points in 401 pieces of 2.5×2.5 km UTM squares were surveyed during the wintering season by 302 observers.

For the analysis, we considered only the field data of points which matched the requirement of field protocol and only for data of species where the given observer was able to identify the species by view and/or sound. In the case of the spring survey, there were 12219 points in 824 pieces of 2.5×2.5 km UTM squares which were surveyed according to the standard field protocol *(Figure 1a)*. 240 bird species were seen/heard at these points, 389 542 individuals of 214 species surveyed within 100 m radius area of these points *(Supplement 1)*. In the case of the winter survey there were 5380 points in 371 pieces of 2.5×2.5 km UTM squares which were surveyed according to the standard field protocol *(Figure 1b)*. 143 bird species were seen/heard at these points, 307 675 individuals of 140 species were surveyed within 200 m radius area of these points *(Supplement 2)*.

Frequency of the surveyed breeding/wintering species was calculated annually by using the ratio of 2.5×2.5 km UTM squares where the given species was seen/heard to all 2.5×2.5 km UTM squares where the given species was surveyed by observers who were able identify the given species by view and/or song. Mean frequency with SE was estimated from annual frequency of the 1999–2012 years for breeding populations and from 2000–2012 years for wintering populations, observed minimal and maximal annual frequency values are given as well *(Supplement 1, 2)*.

Habitat occupancy and preference of the surveyed species (Chamberlain & Fuller 1999) during the breeding season were investigated on the base of CORINE land cover CLC50 GIS database made between 1998–2003 in Hungary (Büttner & Maucha 2006). The spatial resolution of the CORINE CLC50 is 4 ha (1 ha for water bodies). We used this database to classify the habitat

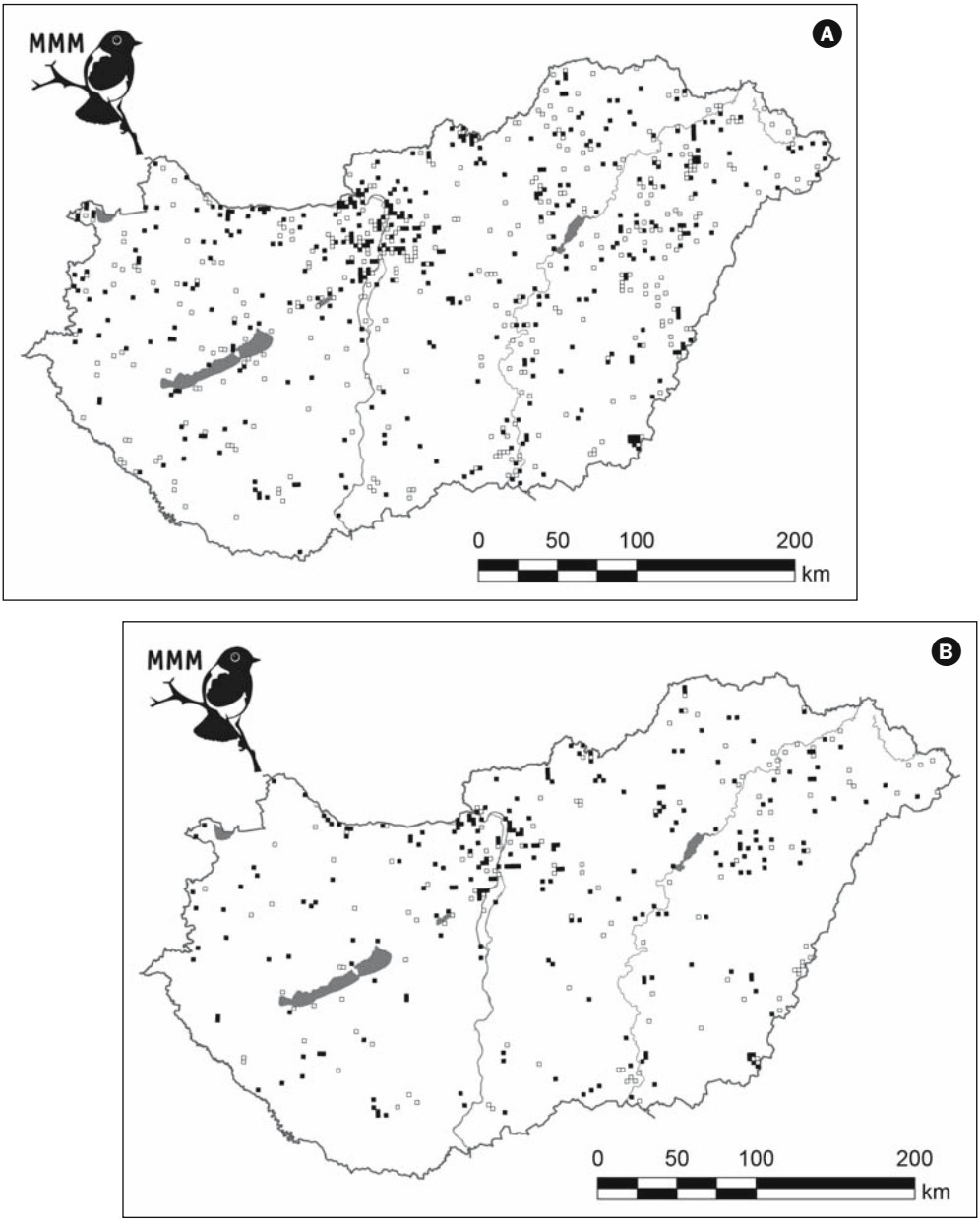


Figure 1. 2.5×2.5 km UTM squares in Hungary surveyed following the standard protocol of the MMM (a) during the breeding seasons of 1999–2012, (b) during the wintering seasons of 2000–2012. Open squares indicated UTM squares surveyed in one year, black squares surveyed more than one year

1. ábra Azon 2,5×2,5 km UTM négyzetek Magyarországon, amelyeket az MMM standard protokollja alapján mértek fel (A) a fészkelési időszakban 1999–2012 során, (B) a telelési időszakban 2000–2012 során. Az üres négyzetek azokat az UTM négyzeteket jelzik, amelyeket csak egy évben, a fekete négyzetek azokat, amelyeket több mint egy évben mértek fel

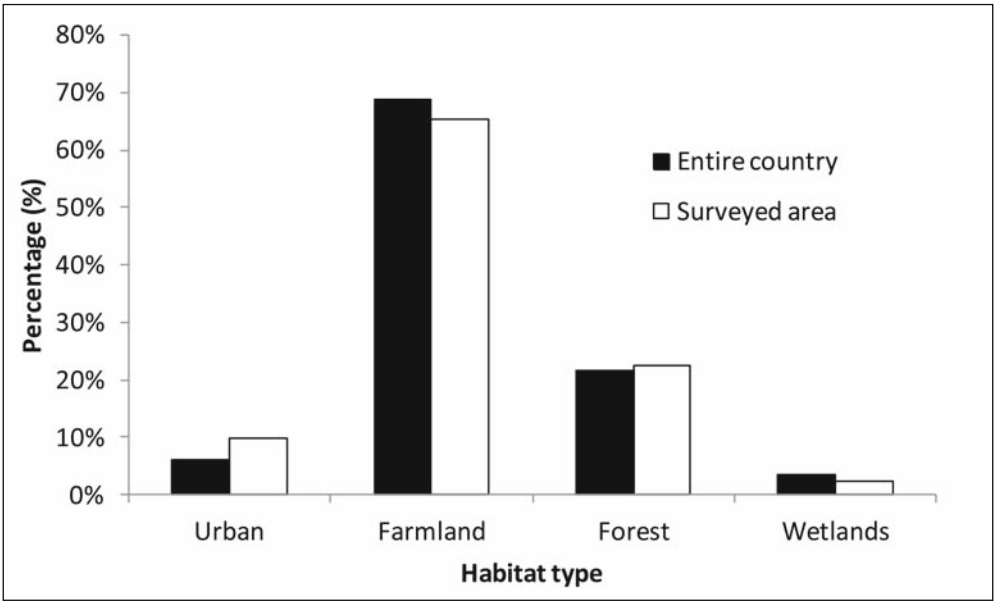


Figure 2. Distribution of the studied four main habitat categories (based on CORINE land cover) in the entire area of Hungary and in the 100 m radius area of the surveyed points (surveyed following the standard protocol of the MMM)

2. ábra A vizsgált négy fő élőhely típus (urbán, mezőgazdasági, erdei, vizes, CORINE land cover adatbázis alapján azonosítva) százalékos területi aránya Magyarországon (Entire country) és az MMM keretében standard módon felmért 100 m sugarú megfigyelési pontok területén (Surveyed area)

types of 100 m radius area of each surveyed points. Habitat was classified into four coded categories: farmland, forest, wetlands and urban habitats on the base of CORINE 1:50000 scale Land Cover first level of habitat description (1: urban, 2: farmland, 3: forest, 4-5: wetlands). Some CORINE habitats (3.2.1.1., 3.2.1.2., 3.3.3.1., 3.3.3.2., 3.3.3.3.) which mainly used for farming instead of forestry in Hungary were classified as farmland habitats. Percentage of the investigated four main habitat categories within the 100 m radius areas of the surveyed points (points surveyed following standard protocol considered, n=12 219) showed similar distribution as the percentage of these habitats in the entire country *(Figure 2)*. The percentages of the urban and forest habitats were little higher in the surveyed area compared to the country total.

Habitat preference of the species was investigated by comparing the relative density of the species in the studied four main habitat categories (Chamberlain & Fuller 1999). The habitat with the highest relative density was identified as preferred habitat of the species. Species regarded as having mixed habitat preference, when relative density was high in more than one habitat. The relative density (observed individual per km^2 in the breeding season) of each species in each main habitat type was calculated on the base of individuals counted in 100 m radius area of the points where more than 2/3 (66%) of the 100 m radius area covered by the given main habitat type (11062 points, 90.5% of

the all surveyed 12219 points were considered) *(Supplement 3)*. In the case of points where survey was made for several years, the mean relative density value was used. All points were considered where the observers were able to identify the given species by view and/or song including zero observations. There were 175 points where birds were not observed, and 97% of these points were covered with farmland habitat type.

We investigated the distribution of the Hungarian breeding population of the species among the four main habitat categories to investigate the habitat occupancy of the species in Hungary, based on the relative density of the species estimated by the MMM *(Supplement 3)*. On the basis of mean relative density of the species in the studied four habitat types, we estimated the population size for each species for the four main habitat categories, using the size of the area of the given habitat types in Hungary and investigated the proportion of the estimated population size in the given habitat to the country total. The main habitat type used by the species in Hungary was selected when more than 2/3 (66%) of the estimated population of the given species observed in the given habitat type (urban, farmland, forest, wetlands). Habitat occupancy regarded as mixed in other cases.

The annual population trends for each species were calculated using TRIM software (Pannekoek & van Strien 2001) which allows for missing counts in the time series and produces unbiased yearly indices and standard errors using Poisson regression (log-linear models; McCullagh & Nelder 1989). TRIM is used frequently in the case of national common bird monitoring schemes in Europe (Gregory *et al.* 2008, 2009). In the case of the breeding population, we used annual counts within the 100 m radius area of the surveyed 15 points in the 2.5×2.5 km UTM squares for trend analysis, whereas in the case of the wintering population, we used annual counts within the 200 m radius area, because of the lower bird density and better detectability in winter. For the analysis of the trend we considered only 2.5×2.5 km UTM squares, which were surveyed at least in two years (407 UTM squares in the breeding season, 239 UTM squares in the wintering season).

For the trend modelling we used the 'Time Effect' basic model of the TRIM (expecting effects for each site and year) (Pannekoek & van Strien 2001). In the case of less common species for which no data was available for some years, linear trend with change points (for years when data available) model of TRIM (Pannekoek & van Strien 2001) was used following the suggestions of the PECBMS for national trends (www.ebcc.info/pecbm/html). The counts were weighted to handle the oversampling in some counties (larger percent of area surveyed in the given county, in the given year for the given species comparing to the entire surveyed area than the ratio of the area of the given county to the entire country). Missing counts of particular sites were estimated ('imputed') from changes in all other sites (Pannekoek & van Strien 2001). The TRIM produced imputed yearly indices for each species which were used for calculating indicators (available: mmm.mme.hu). Indices of the first year of the survey (breeding season: 1999, wintering season: 2000) was the base year with value 1 and all other indices were calculated relative to this base time point. In addition, serial correlation was taken into account. The estimated slopes of the population trend (overall additive slope, based on imputed data, TRIM) reflect average percentage change per year. The overall slope estimate in TRIM

software is converted into discrete categories (trend classification, van Strien *et al.* 2001). The category depends on the overall slope as well as its 95% confidence interval. Based on the EBCC classification we categorized the bird species on a five-point scale: steep decline (–2), moderate decline (–1), stable (0), moderate increase (+1), and strong increase (+2). Steep decline or strong increase classified by TRIM when slope was lower/higher than (–/+) 5% per year, ((–/+) 5% would mean halving/doubling in abundance within 15 years) (van Strien *et al.* 2001). Moderate decline/increase was considered when the trend was significant but its level does not reach the level of steep decline/increase. When the trend was not significant but the confidence limits were sufficiently small, the species was classified as a stable population. If the trend of the given species was not significant and the confidence limits were large, the population trend was classified as uncertain (van Strien *et al.* 2001). During comparison of trends of different groups of species we only considered species which trend was significantly increasing, decreasing or classified as stable. Calculating different indicators we considered species with uncertain trends as well but we excluded data of species from our analysis for which uncertain trend coincided with large standard error of the estimated slope (SE>0.1) to avoid potential biases arising from substantial changes remaining unnoticed due to the large standard errors of the trend estimate.

Migratory strategy of breeding species in Hungary was classified as resident, partial and short distance and long-distance migrant on the base of the Hungarian Bird Migration Atlas (Csörgő *et al.* 2009). We used the Hungarian Bird Migration Atlas (Csörgő *et al.* 2009) to classify the wintering species in Hungary in categories as species formed fully/partly by Hungarian breeding population and as species formed fully by foreign populations.

Indicators, based on groups of species classified by migration strategies, habitat occupancy/preference, sources of wintering population in Hungary and EBCC PECBMS list for Continental biogeographical regions of Europe (version 2013 http://www.ebcc.info), calculated by geometric mean of annual indices (with standard error) of the species considered in the given group following Gregory *et al.* (2005). We used linear regression to analyse the trends of the indicators.

Results

Species frequency in the breeding and wintering season

In the breeding season, from the observed 240 species, mean annual frequency of 106 bird species was higher than 5% *(Supplement 1)* and these species were considered for further analysis *(Table 1)*. During the winter, 140 species were detected from which mean annual frequency of 57 species was higher than 5% *(Supplement 2)* and considered for trend estimation of wintering species *(Table 2)*.

Habitat occupancy and preference of common bird species in the breeding seasons

There were 211 species which were observed within 100 m radius area of the 11062 points where main habitat type was classified on the basis of CORINE land cover *(Supplement 3)*. Habitat occupancy, classified by habitat where more than 2/3 of the population of the

given species observed, showed that among the investigated 106 species the farmland habitat was the most used (44 species, 41.5%), the second was the forest habitat (21 species, 19.8%), the third was the wetland (4 species, 3.8%). There was no species where 2/3 of the population observed in urban habitat, however there were 37 species (34.9%) where the population occurred in large percent in more than one habitat, which were categorized to mixed habitats *(Table 3)*.

Each species which preferred the farmland habitat (20 species) were observed in that habitat to the largest percentage as well. In the case of species with preference of forest habitat (36 species), more than half of them observed in the forest habitat type (58.3%) and the rest (41.7%) used mixed habitats dominantly. In the case of species which preferred the wetland habitat (22 species), most of them (50%) occurred dominantly in the farmland habitat, the second most used habitat was the mixed type (31.8%) and only 4 species (18.2%) observed dominantly in wetland habitat. Species with main preference of urban habitat (16 species) occurred the most in mixed habitats (62.5%) and the rest in farmland (37.5%). Species with no specific habitat preference (12 species) occurred the most in farmland habitat (58.3%) and the rest in mixed habitats (41.7%) *(Table 3)*.

Habitat classification

For some species the habitat classification for the Continental part of Europe suggested by the Pan-European Common Bird Monitoring Scheme (PECBMS) differs from the results we obtained for the population breeding in Hungary. Based on the available data there is opportunity to consider additional/different species and categories for classification.

Among the 22 species classified as farmland bird species in the PECBMS there were two *(Emberiza citrinella, Streptopelia turtur)* which density was the highest in forest habitats and the habitat occupancy indicated mixed habitats (farmland and forest) in Hungary, thus the best to consider these species as species using mixed habitats *(Table 1)*. There were 17 species in the PECBMS list suggested as common birds which use 'others' habitats (no farmland/forest birds or using mixed habitats), however more than 2/3 of the population of these species occurred in farmland habitats in Hungary, thus the breeding population of these species was highly dependent on farmland habitats. Among these 17 species, there were four species *(Phasianus colchicus, Merops apiaster, Anthus campestris, Locustella naevia)* which species preferred the farmland habitats, the rest preferred the urban habitat *(Pica pica, Carduelis carduelis)*, the wetland habitat *(Ardea cinerea, Circus aeruginosus, Tringa totanus, Acrocephalus schoenobaenus, Acrocephalus palustris, Acrocephalus arundinaceus)* or had no obvious preference (mixed habitats) *(Buteo buteo, Upupa epops, Motacilla alba, Oenanthe oenanthe, Corvus corone cornix)*. Above the formerly mentioned species, there were 7 breeding species which populations dominantly (2/3) occurred in farmland habitat in Hungary and needed to reconsider as species highly related on farmland. Among these species three preferred farmland *(Circus pygargus, Coturnix coturnix, Tringa glareola)*, three preferred wetland *(Botaurus stellaris, Egretta alba, Riparia riparia)* and one preferred urban habitat *(Falco subbuteo)*.

In the case of 22 species classified as forest bird by PECBMS, there were 6 species *(Accipiter nisus, Picus viridis, Anthus trivialis, Sylvia atricapilla, Phylloscopus trochilus* and *Muscicapa striata)* which used mixed

habitats in Hungary on the base of habitat occupancy and their populations depend on more than one habitat (farmland and forest). There were five species *(Dendrocopos major, Lullula arborea, Erithacus rubecula, Parus caeruleus, Fringilla coelebs)* which suggested as species with 'others' habitat occupancy by PECBMS, however these species preferred the forest habitat and more than 2/3 of the population occurred in forest habitat in Hungary.

There were four species among the 106 most common species *(Phalacrocorax carbo, Nycticorax nycticorax, Anser anser, Locustella luscinioides)* which population dominantly (2/3) occurred in wetland habitat in Hungary.

There were 37 species where dominant part of the population occurred in more than one habitat type in Hungary and we regard them as species using mixed habitat type. Habitat preference of these species: (27%) urban, (40.5%) forest, (18.9%) wetland, (13.5%) no preference (mixed habitat). 25 species of these species were classified in 'others' category by the PECBMS as well.

Population trend and migration strategies

There were 26 species with decreasing, 28 species with increasing and 20 species with stable population trends and 33 species with uncertain trend on the basis of trend classification criteria of the TRIM program *(Table 1)*. There was a significant difference in the population trends (decreasing, stable, increasing) regarding the different migration strategies (resident, partial and short distance migrant, long distance migrant) *(χ^2=14.494, P=0.005, Fisher's Exact Test) (Figure 3)*.

There was no difference in the population trend between resident and partial and short distance migrant species *(χ^2=0.284, P=1, Fisher's Exact Test)*. The number of species with increasing trend was higher (52.6%, 53.6%) than the number of species with decreasing or stable trend (26.3%, 21.4%).

Comparison of population trends of long distance migrant species to resident and partial and short distance migrant species showed that long distance migrant species had different population trends *(χ^2=14.420, P<0.001, Fisher's Exact Test)*. In the case of the long distance migrant species the proportion of species with decreasing population trend (57.8%) was higher than species with increasing (7.7%) and stable population trend. Among the long distance migrant species there were only two species *(Jynx torquilla, Ficedula albicollis)* with increasing population trend.

Population trends and habitat occupancy

The population trends showed different pattern among species using different habitats classified by habitat occupancy (farmland, forest and mixed) *(χ^2=15.714, P=0.003, Fisher's Exact Test) (Figure 4)*. There was significant difference in the trends between the number of species mainly using farmland habitat compared to the number of species mainly using forest habitat *(χ^2=15.192, P<0.001, Fisher's Exact Test)*. More than half (51.6%) of the species which dominantly occurred in farmland habitat had decreasing trends, and only 16.1% had increasing trends. In the case of species which mainly occurred in forest habitat, increasing trends found for 73.3% of the species and only one species *(Lullula arborea)* of this group (6.7%) had decreasing trend.

Decreasing trends were more common among farmland birds compared to species with mixed habitat usage but the differen-

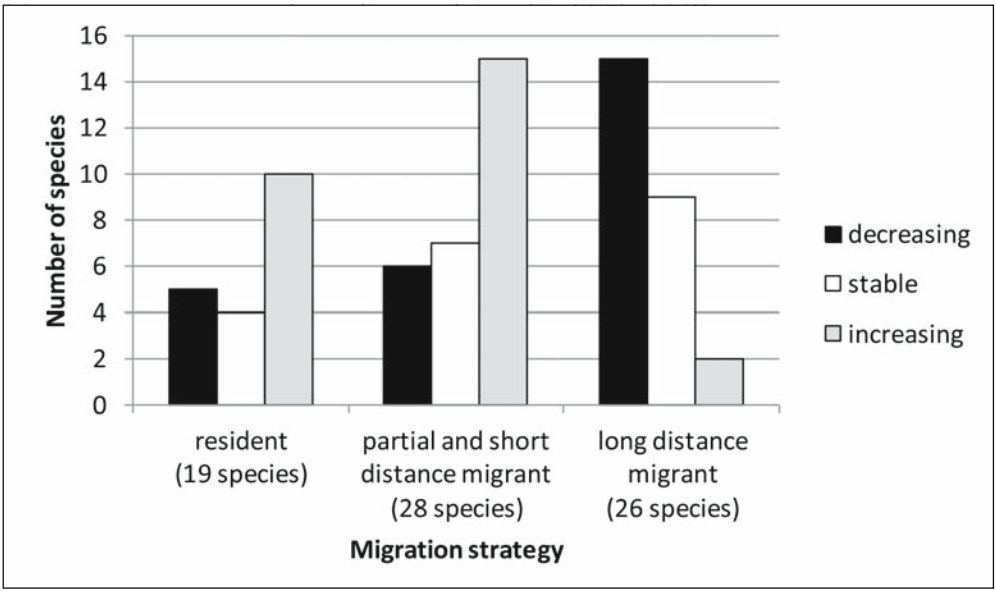


Figure 3. Population trends and migration strategies of species for which significant decreasing, increasing and stable trend were properly estimated by the TRIM software

3. ábra A TRIM program alapján szignifikáns csökkenő, stabil és növekedő állomány trendet mutató fajok száma a vizsgált három vonulási stratégiával (állandó, részlegesen/rövidtávon vonuló, hosszútávon vonuló) jellemezhető csoportok esetében. A csoportonként figyelembe vett fajok száma zárójelben megadva

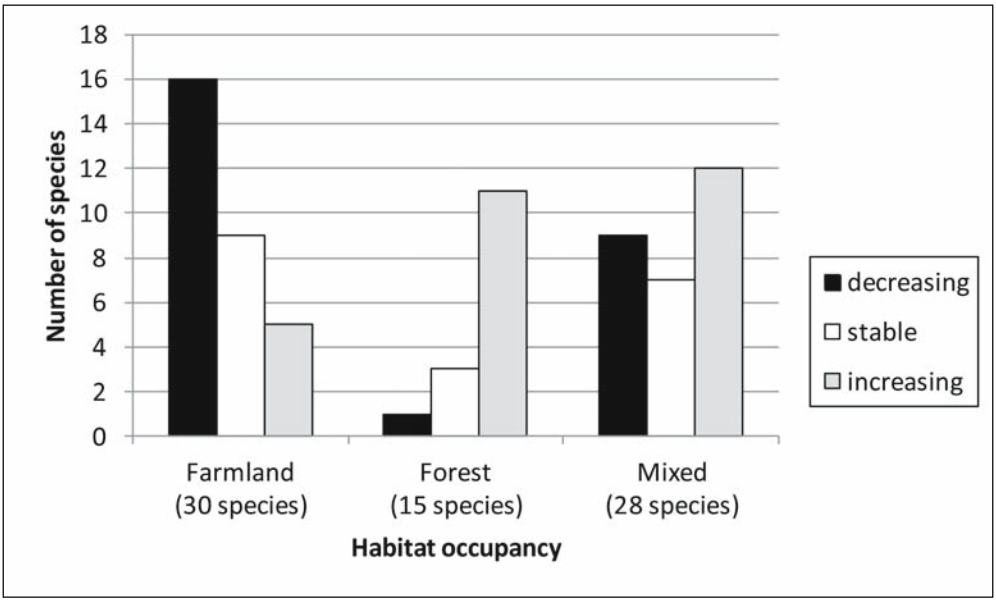


Figure 4. Population trends and habitat occupancy of species for which significant decreasing, increasing and stable trend were properly estimated by the TRIM software

4. ábra A TRIM szoftver alapján szignifikáns csökkenő, stabil, növekedő állomány trendet mutató fajok száma a vizsgált három élőhely használattal (mezőgazdasági, erdei, vegyes) jellemezhető csoportok esetében. A csoportonként figyelembe vett fajok száma zárójelben megadva

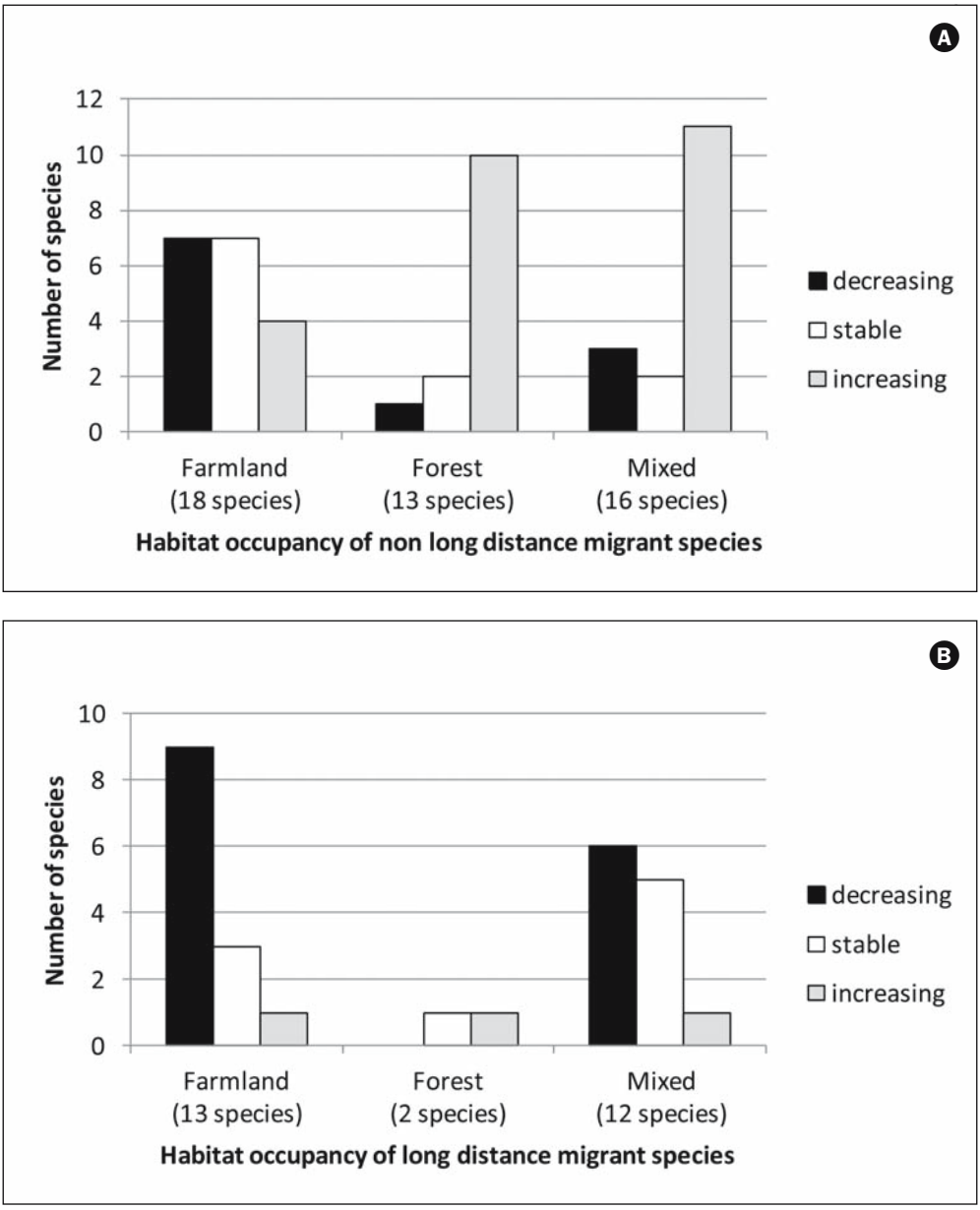


Figure 5. Population trends and habitat occupancy of (A) resident, partial and short distance migrant species and (B) long distance migrant species for which significant decreasing, increasing and stable trend were properly estimated by the TRIM software

5. ábra A TRIM program alapján szignifikáns csökkenő, stabil, növekedő állomány trendet mutató, (A) nem hosszútávon vonuló, (B) hosszútávon vonuló fajok száma a vizsgált három élőhely használattal (mezőgazdasági, erdei, vegyes) jellemezhető csoportok esetében. A csoportonként figyelembe vett fajok száma zárójelben megadva

ce was not significant *(χ^2=5.126, P=0.087, Fisher's Exact Test)*. Increasing trend among species which use forest habitat was more common than among species which use mixed habitat but the difference was not significant between these groups *(χ^2=4.383, P=0.107, Fisher's Exact Test)*.

Population trends, migration strategies and habitat occupancy

Among the 47 non long distance migrant species (resident and partial and short distance migrant), there were significant difference between number of species with increasing, stable and decreasing trends using different habitats *(χ^2=11.341, P=0.018, Fisher's Exact Test) (Figure 5a)*. Population increase was less common (22.2%) among species which use mainly farmland habitat, comparing to the number of species mainly using forests (76.9%) *(χ^2=8.814, P=0.015, Fisher's Exact Test)* and compared to number of species which mainly use mixed habitat (68.8%) *(χ^2=7.269, P=0.026, Fisher's Exact Test)*. There was no significant difference between the number of species which use mainly forest and mixed habitats *(χ^2=0.832, P=0.844, Fisher's Exact Test)*. In the case of these groups the most species had increasing trends.

In the case of the 27 long distance migrant species for which proper trend data was available to classify population trends (decreasing, stable, increasing) there was no significant difference between groups of species with different habitat occupancy *(χ^2=5.106, P=0.262, Fisher's Exact Test) (Figure 5b)*.

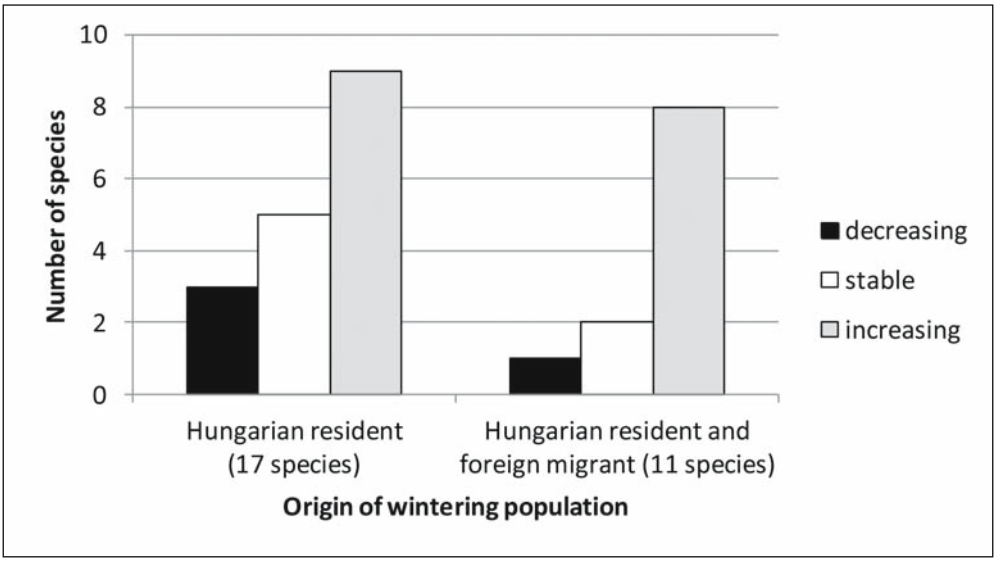


Figure 6. Population trends of wintering species and origin of these populations (1) mainly from Hungarian resident population, (2) from Hungarian resident and foreign migrant populations, for which significant decreasing, increasing and stable trend were properly estimated by the TRIM software

6. ábra A TRIM program alapján szignifikáns csökkenő, stabil, növekedő állomány trendet mutató telelő fajok száma az állományok származása alapján (1- főként magyar állandó állomány, 2- magyar és külföldi vonuló állomány) jellemezhető csoportok esetében. A csoportonként figyelembe vett fajok száma zárójelben megadva

Population trend of the wintering species in Hungary

There were 4 species with significantly decreasing population, 7 species with stable population trend and 17 species with significantly increasing population *(Table 2)* based on the trend classification criteria of the TRIM.

Population trends of the species which wintering population mainly formed by the Hungarian resident population did not show difference from species formed by mixed Hungarian resident and foreign wintering populations *(χ^2=1.063, P=0. 638, Fisher's Exact Test) (Figure 6)*.

Indicators of the breeding season

For the calculation of indicators of different migration strategies and habitat occupancy, we considered the annual indices of 101 species. From the 106 species for which trends were estimated, we excluded data of five species *(Anser anser, Circus pygargus, Tringa glareola, Apus apus, Anthus pratensis)* with extremely uncertain trends, which showed very high standard error of the estimated slope (SE>0.1).

Migration strategies

We calculated three indicators from the annual population indexes of the studied spe-

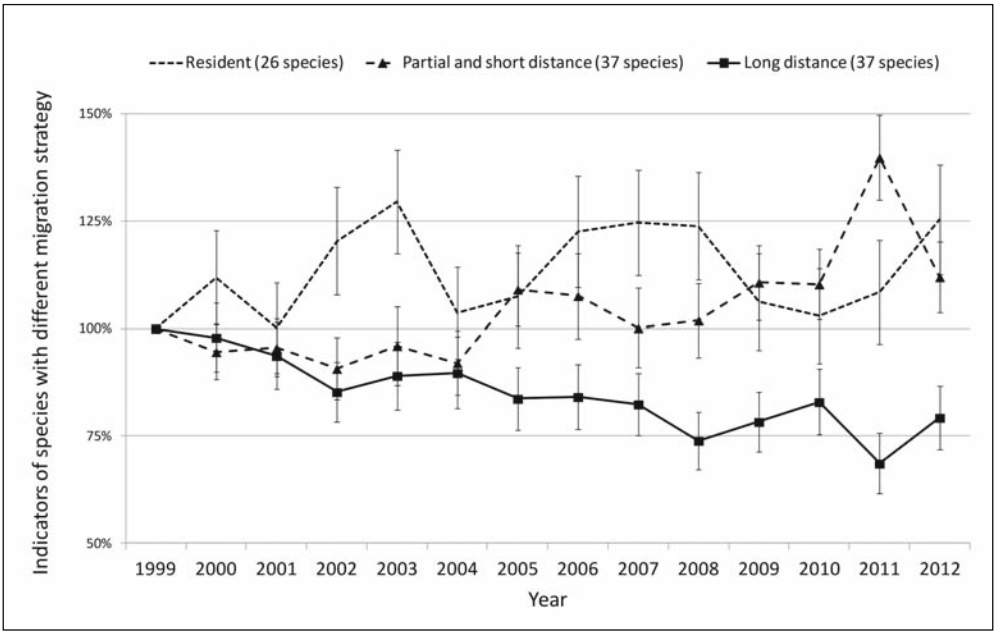


Figure 7. Indicators values of resident, partial and short distance migrant and long distance migrant bird species for the period of 1999–2012 in Hungary. Geometric mean (SE) calculated for each groups on the base of annual imputed index produced by TRIM software. Number of species considered for each groups is given in bracket

7. ábra Állandó, részlegesen/rövidtávon vonuló és a hosszútávon vonuló madárfajok indikátor értékei Magyarországon 1999–2012 között. Mértani átlag, annak hibája (SE) számolva minden csoport esetében a TRIM program éves imputed index értékei alapján. A csoportonként figyelembe vett fajok száma zárójelben megadva

cies on the basis of migration strategies as: 1- resident species indicator (26 species), 2- partial and short distance migrant species indicator (37 species) and 3- long distance migrant species indicator (37 species) *(Figure 7)*.

In the case of the indicator of long distance migrants there was a significantly decreasing trend *(slope= -0.018 (SE=0.003), F=41.083, df=1,12, P<0.001, R^2=0.774)*.

Indicators of partial and short distance migrant species showed significantly increasing trends during the studied period *(slope= 0.021 (SE=0.006), F=12.597, df=1,12, P=0.004, R^2=0.512)* whereas trend of the indicator of resident species was not significant *(F=0.690, df=1,12, P=0.422)*.

Habitat usage

We calculated indicators from the annual population indices of the studied species based on the habitat occupancy for 1- farmland habitat (FAH) (41 species), 2- forest habitat (FOH) (21 species) and 3- mixed habitats (MIH) (36 species) *(Figure 8a)*.

The indicator based on all bird species using dominantly farmland in Hungary (FAH) showed significant decrease *(slope= -0.011 (SE=0.003), F=10.801, df=1,12, P=0.007, R^2=0.474)*.

Indicators of species using forest (FOH) showed significantly increasing trend *(slope= 0.031 (SE=0.004), F=57.468, df=1,12, P<0.001, R^2=0.827)*, whereas trend of the indicator of species using mixed habitats (MIH) was not significant *(F=0.258, df=1,12, P=0.620)*.

We calculated indicators using the PECBMS list for Continental part of Europe as well: 1- Farmland Bird Indicator (FBI) (21 species), 2- forest bird indicator values (22 species) and indicators for 'others' species using mixed and/or other habitats (45 species) *(Figure 8b)*.

Farmland Bird Indicator (FBI) based on the PECBMS list showed significant decreasing trend *(slope= -0.020 (SE=0.005), F=13.551, df=1,12, P=0.003, R^2=0.530)*.

Indicator of forest birds has significant increasing trend *(slope= 0.028 (SE=0.005), F=32.080, df=1,12, P<0.001, R^2=0.728)*. Indicator of species classified as 'others' in the PECBMS list showed no significant trend *(F=2.324, df=1,12, P=0.153)*.

In the case of farmland habitat indicator (FAH) we calculated three partial indicators based on the habitat preference: 1- farmland birds with preference of farmland habitat (FAFH) (17 species), 2- farmland birds with preference of wetland habitat (FAWH) (11 species), 3- farmland birds with preference of urban and mixed habitat (FAMH) (13 species) *(Figure 9)*.

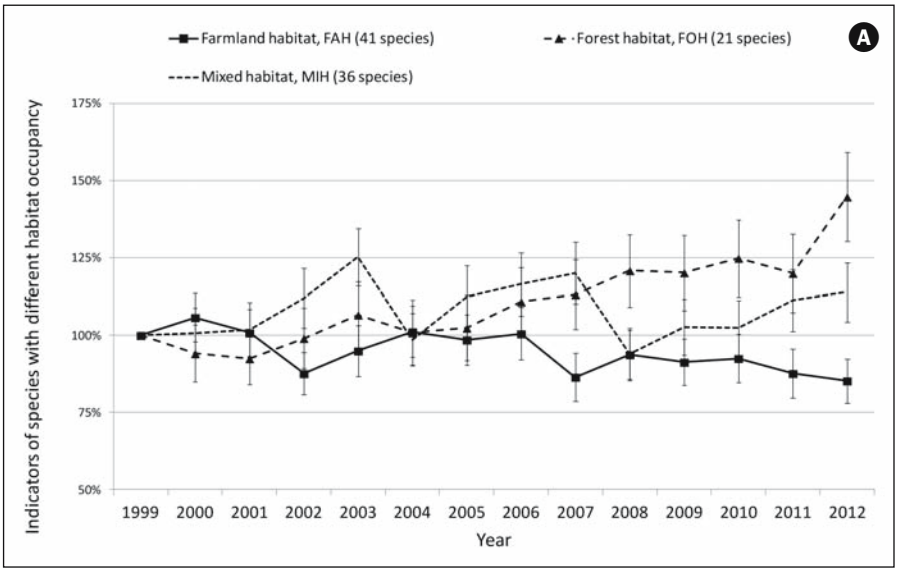
In the case of indicators based on species preferred the farmland habitat (FAFH) there was a significant decline *(slope= -0.026 (SE=0.004), F=53.560, df=1,12, P<0.001, R^2=0.817)*.

Indicators of farmland species with urban/mixed habitat preference (FAMH) and indicators of farmland birds with preference of wetland habitats (FAWH) there was no significant trend (FAMH*: F=0.162, df=1,12, P=0.694;* FAWH: *F=0.195, df=1,12, P=0.666*).

Migration strategy and habitat usage of breeding population

We calculated specific indicators for considering migration strategy (long distance migrant vs. non long distance migrant) and habitat occupancy *(Figure 10)*.

Indicators of non long distance migrant species with farmland habitat occu-



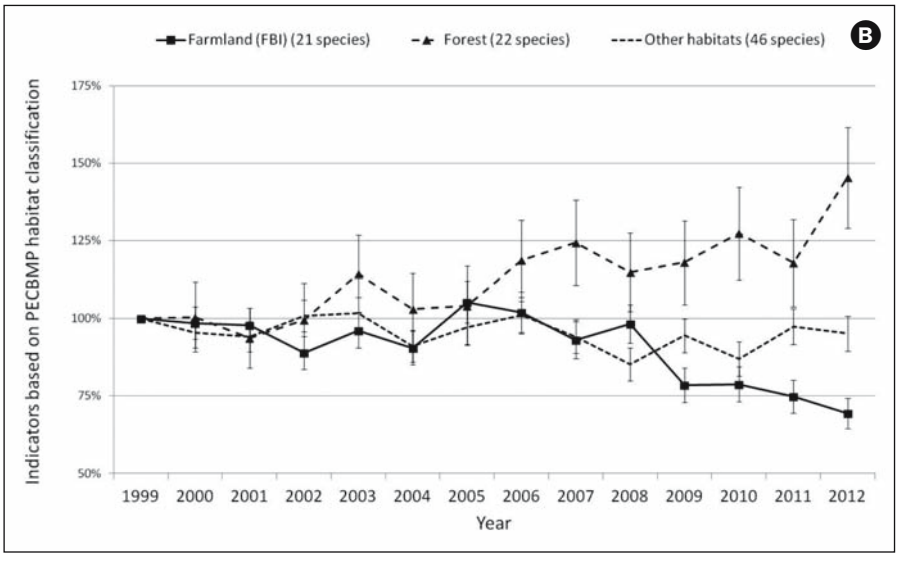


Figure 8. Indicators values of species grouped (A) on the base of habitat occupancy in Hungary (B) on the base EBCC PECBMS list for Continental Europe. Species considered as using mixed habitat if less than 2/3 of the population occurred in the most used main habitat type (urban, farmland, forest, wetland). Species grouped to other habitats when use other habitats than farmland and forest or use several habitats. Geometric mean (SE) calculated for each groups on the base of annual imputed index produced by TRIM software. Number of species considered for each groups is given in bracket

8. ábra Indikátor értékek (A) a magyarországi élőhely használat, és (B) az EBCC PECBMS Kontinentális lista élőhelyi besorolása alapján alkotott fajcsoportok esetében. Amennyiben adott faj hazai állományának kevesebb, mint 2/3-a volt megfigyelve egy adott fő élőhely típusban (urbán, mezőgazdasági, erdei, vizes) a fajt vegyes (mixed) élőhely használatúként volt kezelve. Az EBCC PECBMS esetén az egyéb (others) csoportba azokat a fajokat sorolták, amely nem mezőgazdasági (FBI) vagy erdei, illetve vegyes élőhellyel jellemezhető. Mértani átlag, annak hibája (SE) számolva minden csoport esetében a TRIM program éves imputed index értékei alapján. A csoportonként figyelembe vett fajok száma zárójelben megadva

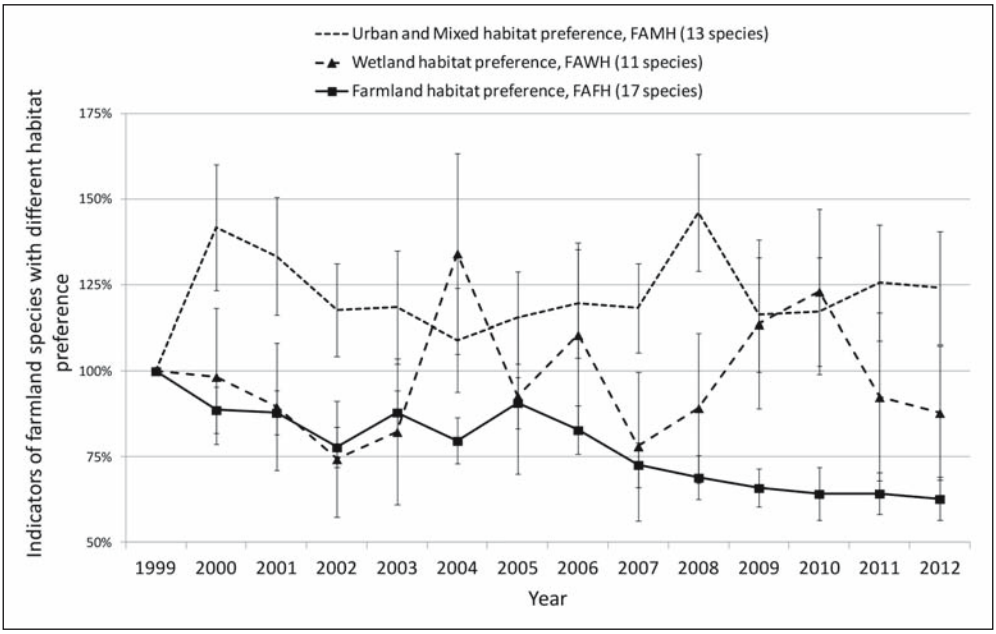


Figure 9. Indicators values of species use mainly the farmland habitat and grouped on the base of habitat preference in Hungary. Species preferred urban and mixed habitat types handled in one group. Geometric mean (SE) calculated for each groups on the base of annual imputed index produced by TRIM software. Number of species considered for each groups is given in bracket

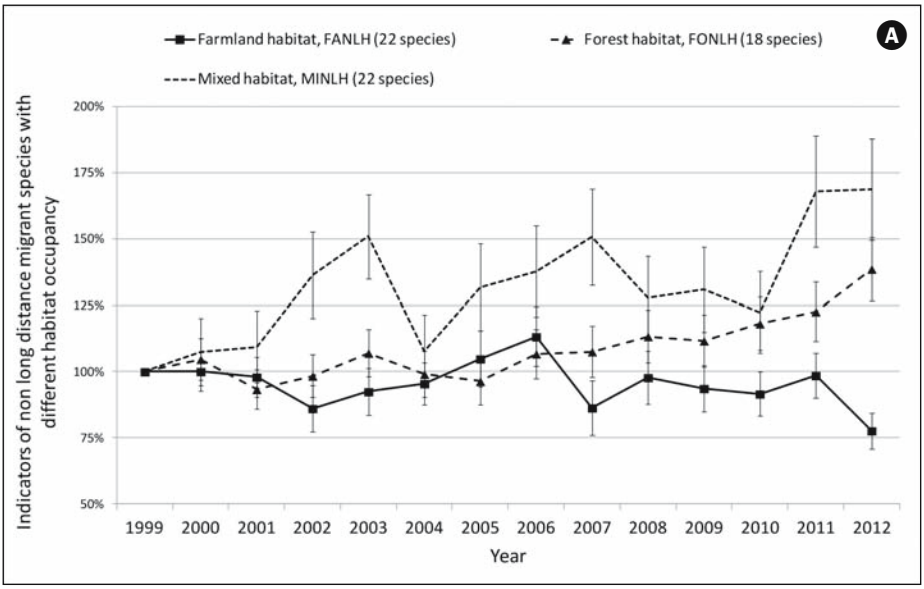
9. ábra Indikátor értékek a Magyarországon a mezőgazdasági élőhelyet használó és különböző élőhely preferenciával (urbán és vegyes, vizes, mezőgazdasági) jellemezhető fajcsoportok esetében. Az urbán és vegyes élőhelyeket preferáló madárfajok egy csoportba sorolva. Mértani átlag, annak hibája (SE) számolva minden csoport esetében a TRIM program éves imputed index értékei alapján. A csoportonként figyelembe vett fajok száma zárójelben megadva

pancy (FANLH) had no significant trend *(F=1.384, df=1,12, P=0.262)*, whereas indicators of species with similar migration strategy but different habitat occupancy (forest, mixed habitat) had significant increase (FONLH: *slope= 0.026 (SE=0.005), F=26.203, df=1,12, P<0.001, R^2=0.704*; MINLH: *slope= 0.033 (SE=0.012), F=7.036, df=1,12, P=0.022, R^2=0.39*) *(Figure 10a)*.

Indicators of long distance species with farmland and mixed habitat occupancy showed significant decreasing trends, the level of decrease was higher for indicator of species with mixed habitat occupancy (FALH: *slope= -0.015 (SE=0.005), F=8.856, df=1,12, P=0.012, R^2=0.425*; MILH: *slope= -0.028 (SE=0.005), F=29.060, df=1,12, P<0.001, R^2=0.708*) *(Figure 10b)*.

Indicators based on population trends of the wintering species in Hungary

From the 57 species for which trends were estimated, we excluded data of seven species *(Anser fabalis, Anser albifrons, Anser anser, Haliaeetus albicilla, Accipiter gentilis, Larus ridibundus, Fringilla montifringilla)* with very high standard error of the estimated slope (SE>0.1).



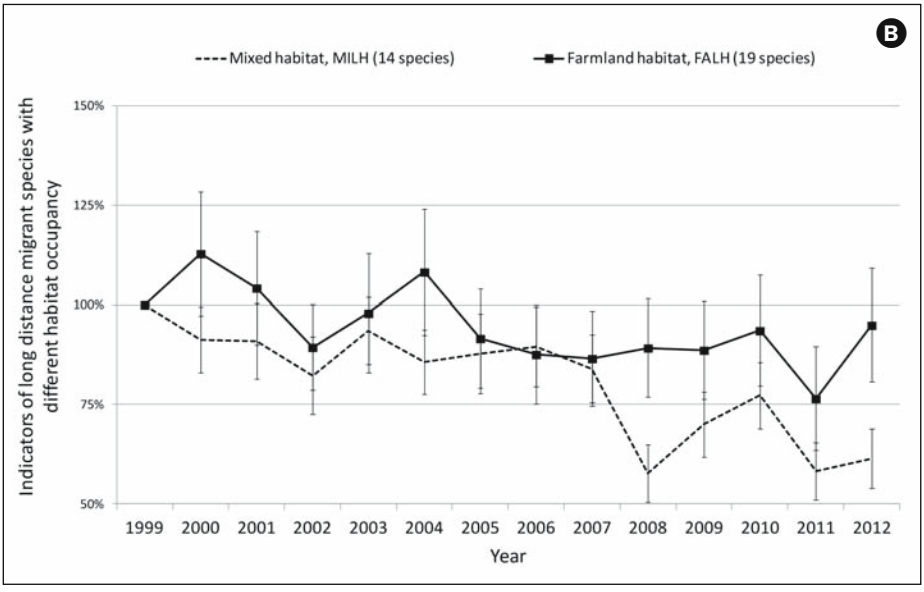


Figure 10. Indicators values of (A) non long distance migrant (resident, partial and short distance) species (B) long distance migrant species grouped on the base of habitat occupancy in Hungary. Species considered as using mixed habitat if less than 2/3 of the population occurred in the most used main habitat type (urban, farmland, forest, wetland). Geometric mean (SE) calculated for each groups on the base of annual imputed index produced by TRIM software. Number of species considered for each groups is given in bracket

10. ábra Indikátor értékek (A) nem hosszútávon vonuló (állandó, részlegesen/rövidtávon vonuló), (B) hosszútávon vonuló fajok különböző élőhelyeket (mezőgazdasági, erdei, vegyes) használó fajcsoportjaik esetében. Amennyiben adott faj hazai állományának kevesebb, mint 2/3-a volt megfigyelve egy adott fő élőhely típusban (urbán, mezőgazdasági, erdei, vizes), a fajt vegyes (mixed) élőhely használatúként volt kezelve. Mértani átlag, annak hibája (SE) számolva minden csoport esetében a TRIM program éves imputed index értékei alapján. A csoportok esetében figyelembe vett fajok száma megadva a zárójelben

We calculated indicators for wintering species, which wintering population in Hungary formed fully or partly by the Hungarian breeding population, based on the habitat occupancy of the Hungarian breeding population: 1- wintering species with farmland habitat occupancy (WFAH), 2- wintering species with forest habitat occupancy (WFOH), 3- wintering species with mixed habitat occupancy (WMIH) *(Figure 11)*.

Indicators of wintering species with farmland habitat occupancy and mixed habitat occupancy in the breeding season showed significant increasing trends during 2000–2012, species with mixed habitat occupancy had the strongest increase (WFAH: *slope= 0.049 (SE=0.020), F=6.261, df=1,11, P=0.029, R^2=0.363*; WMIH: *slope= 0.101 (SE=0.013), F=60.017, df=1,11, P<0.001, R^2=0.845*).

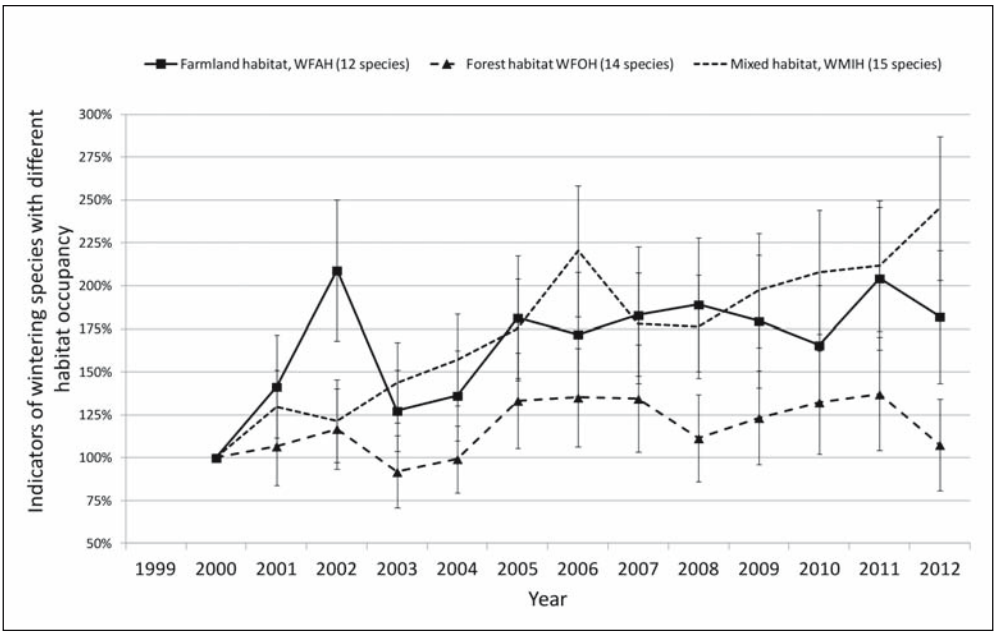


Figure 11. Indicators values of wintering species grouped on the base of habitat occupancy in Hungary in the breeding season. Only wintering species were considered which wintering population formed fully and/or partly by Hungarian breeding population. Species considered as using mixed habitat if less than 2/3 of the population occurred in the most used main habitat type (urban, farmland, forest, wetland) in the breeding season. Geometric mean (SE) calculated for each groups on the base of annual imputed index produced by TRIM software. Number of species considered for each groups is given in bracket

11. ábra A különböző élőhelyeket használó (mezőgazdasági, erdei, vegyes), Magyarországon telelő fajcsoportok indikátor értékei. Csak azon telelő fajok figyelembe véve, amelyek telelő állománya részben vagy egészben a hazai fészkelő állományhoz tartozik. Amennyiben adott faj hazai állományának kevesebb, mint 2/3-a volt megfigyelve egy adott fő élőhely típusban a fészkelési időszakban (urbán, mezőgazdasági, erdei, vizes), a faj vegyes (mixed) élőhely használatúként volt kezelve. Mértani átlag, annak hibája (SE) számolva minden csoport esetében a TRIM program éves imputed index értékei alapján. A csoportok esetében figyelembe vett fajok száma megadva a zárójelben

Indicator of wintering species with forest habitat occupancy (WFOH) had a weak not significant increasing trend (*slope= 0.021 (SE=0.011), F=3.853, df=1,11, P=0.075*).

Discussion

The MMM monitoring scheme provided the first relevant information about the frequency of the breeding and wintering species in Hungary, based on quantitative data of representative sampling of the main habitats and covering the entire country. We were able to identify 106 breeding and 57 wintering common species in Hungary, proper for investigating the habitat relation of these species and estimating trends in the scale of the country. The standardised field protocol let to compare frequencies of bird species active during daylight but this protocol was not proper for rare species and for species with high activity at night as most owl or crake species. During the comparison of the estimated frequencies the differences in the detectability of the species (Bibby *et al.* 2000) has to be considered as well.

We used information based on trend classification by TRIM (increase, stable, decline) to investigate the species trends first because it provides a more conservative and robust approach than considering the value of estimated slope of each investigated species, including species with uncertain trends. We have developed indicators for migratory strategies and habitat occupancy considering these characteristics in combination, using Gregory *et al.* (2005) approach based on annual population indices produced by the TRIM. These indicators could provide detailed information about groups of species and habitats they use by considering more species than the former analysis based data of species only with trend classification.

Among the 74 breeding species for which direction of the population trends were classified, there was significant difference on the basis of migration strategy among the species. Population decline was significantly more common among the long distance migrant species than among resident, partly or short migrant species. Among the 27 investigated long distance migrant common species in Hungary, more than half had significant decline. There was an opposite situation in the case of the 47 resident, partial and short migrant species, where more than half of them has increasing trend in Hungary. Indicators of migration strategies of common breeding bird species in Hungary, in accordance with the analysis based on species with trend classification, showed continuous decline of the long distance migrant birds and an opposite increase of the partial and short distance species *(Figure 7)*.

Our result is in concordance with several studies which showed the most threatened status of long distance migrant species in Europe comparing with species with other migration strategies (Berthold *et al.* 1998, Sanderson *et al.* 2006, Møller 2008, Heldbjerg & Fox 2008, Jiguet *et al.* 2009). The decline of the long distance migrants is a general phenomenon in Europe and presumably the climate change has an important role (Both & Visser 2001, Both *et al.* 2006) among others as habitat change, agricultural intensification. Opposite trends of partial and short distance migrant species comparing to long distance migrant species in Hungary support the importance of climate change related issues to explain the found processes (Jiguet *et al.* 2010). The observed trends are usually a combination of breeding and non-breeding area effects, which both

affected by climate change (Morrison *et al.* 2013).

Monitoring of common bird species with formal sampling protocol let us to monitor not only the given species but the condition of habitats these species use for breeding/foraging (Bibby 1999, Gregory *et al.* 2005). One of the main purpose of the MMM like common bird monitoring schemes in Europe (e.g. Gregory *et al.* 1996, Del Moral *et al.* 2010, Jiguet *et al.* 2012) is to use groups of species as indicators of the main habitats, for which species selection has a crucial importance (Gregory *et al.* 2005). In the case of the most common bird species in Europe, the classification of species in relation to the habitat to which the species highly related as Tucker and Evans (1997) present, allow to form groups for indicators. However, investigation of the list of species considered as indicators of a given habitat in a given country or region is needed using quantitative data over the expert judgement (see Gregory & van Strien 2010), because of the differences of species habitat use among these geographical areas (frequency, importance of the given habitat type in nesting/foraging which could differ among countries)

In our work, we used the CORINE land cover GIS database of Hungary (Büttner & Maucha 2006) to investigate the habitat preference and habitat occupancy of the most common breeding species in Hungary on the base of the observation data of MMM at known localities between 1999 and 2012. There was no similar investigations in Hungary before, the existing general overview of Hungarian breeding species (Haraszthy 1998), contains information about habitat related information, based on studies which used different methods and carried out on varying spatial and temporal scale. The spatial resolution of the used CORINE habitat database let us to investigate mainly at the level of landscape the relation of the given species to the four main habitat types (urban, farmland, forest, wetland). Estimating the relative densities of the given species in the main studied habitat types with knowing the extension of these habitats in Hungary allowed to estimate the distribution of the Hungarian population of these species among these main habitats which let us to investigate the habitat occupancy of these species.

Investigation of habitat occupancy of common species showed the large importance of farmland habitats on breeding fauna, more than 40% of the species dominantly use these habitats for nesting/foraging. The classification of habitat preference by comparing the relative densities of the species in the studied main habitat types, expecting the largest density in the preferred habitat (Brown 1969, Fretwell & Lucas 1970), allow to investigate in more detail the relation of the given species to the studied habitats. This kind of approach of habitat preference admitted that e.g. the most *Acrocephalus* species preferred the wetland habitat, however at the same time dominant part of the population use the farmland habitat in Hungary. The spatial resolution of the used CORINE land cover is coarse, and it is not possible to identify the smaller than (1–4 ha) size wetland patches in the farmland areas, which can explain the 'contradiction'. However, these small patches of wetland habitat are important part of the farmland landscape in Hungary, management and using (e.g. melioration) is highly related to the practice in this habitat in Hungary which suggests to consider these species for indicator of farmland habitat as well.

Considering the habitat occupancy of the studied species altogether with habitat preference (Chamberlain & Fuller 1999), using es-

timations based on large relevant dataset, allow us to verify the internationally suggested list of indicators (PECBMS) for the region of Hungary and to develop country specific new indicators of habitats. In the case of the list of farmland bird indicator (FBI) of the PECBMS (22 species), we found that the FBI largely consider species with obvious usage of farmland habitats in Hungary. We identified two species only in the FBI list *(Streptopelia turtur* and *Emberiza citrinella)* where nor the habitat occupancy and nor the habitat preference did not relate dominantly to farmland habitat in Hungary. Among the 44 species, which breeding populations in Hungary dominantly use the farmland habitat, we identified three groups on the base of the habitat preference (farmland, wetland, urban and mixed habitat). On the base of these groups, we developed specific indicators of the farmland habitats which allow to use country specific farmland bird indicators, which could indicate processes in the farmland in more detail, than using only one simple indicator. Our work let us to investigate the species list of forest and mixed habitat indicators of PECBMS and to develop country specific list for these indicators as well.

Significant declining population trends were more common among those breeding species, which dominantly use the farmland habitat in Hungary *(Figure 4)*. More than half of farmland species with trend classification had significant decline whereas in the case of species with forest habitat occupancy, more than 2/3 of species had significant increasing trend. We have found the same direction in the case of indicators based on habitat occupancy. The farmland birds had significant declining trend and the birds of forest had significant increasing trend. Our results are similar as found on the level of Europe (Gregory *et al.* 2007, Gregory & van Strien 2010). This general pattern can be observed in most European countries, but the detailed trends and the underlying causes can be very different (Wretenberg *et al.* 2006, Reif *et al.* 2008). Considering the species selection of the PECBMS for habitat indicators yield similar results as habitat indicators based on classification of our habitat occupancy data which considered more species. The decline of farmland species was more steep using PECBMS species list (FBI) comparing to indicators based on habitat occupancy (FAH) in Hungary. In the case of indicators of the farmland habitat based on habitat occupancy data (FAH) more species (41 species) were considered than in the case of farmland bird indicator (FBI) of the PECBMS (21 species) and FAH formed by species with different habitat preference which condition we need to consider. We developed three separate indicators for species dominantly use the farmland habitat in Hungary on the base of the habitat preference. Indicator of farmland bird species with preference of farmland habitat (FAFH) showed steep significant decline, whereas indicators of farmland birds with preference of wetland and urban and mixed habitat did not show declining trends *(Figure 9)*. Our results showed that behind the decline of the farmland birds the farmland related effects could play the main role.

Our results suggest that in Hungary the indicator based on species with habitat preference and occupancy of farmland habitat (FAFH) could be the most adequate indicator to follow the condition of farmland habitat in Hungary and similar selection criteria could be adequate for forest habitat (FOH). All investigated indicators of farmland birds (FBI, FAH, FAFH) showed that declining trend has started after joining of Hungary to the EU in 2004.

The increase of forest birds, indicated by large number of these species with increasing trends and the increasing trends of indicators of forest birds *(Figure 4, 8)* very probably indicate the extension of the areas of forest in Hungary. The forested area increased with 7% in Hungary during 2000–2012 (www.ksh.hu) mainly by acacia and poplar afforestation in areas used for farming formerly. The afforestation could explain the decrease of several farmland species as well (Butler *et al.* 2010). The observed pattern is very similar to found in the Czech Republic (Reif *et al*. 2007).

To interpret the found population trends we need to consider the migratory strategy of these species above the habitat usage because of the opposite processes of long distance versus non long distance migrant species in Hungary. Among non long distance migrants, for which the increase were the commonest trend, species with farmland habitat occupancy were not able to benefit the same level of the potentially climate related positive changes (Jiguet *et al.* 2010) as species with forest and mixed habitat occupancy. Only the 22% of species which use dominantly the farmland habitat had significant increase, while the declining and stable trends are more common *(Figure 5)*. Indicators combining migration strategy and habitat occupancy, in concordance with analysis of trend classification, showed that indicators of non long distance migrant, which dominantly use the forest and the mixed habitat had significant increase but for species using farmland there was no similar trend *(Figure 10a)*. Populations of non long distance migrant species, using dominantly the farmland habitat, were not able to realise the benefit of climate related changes, which indicate the habitat related adverse effects independently from the influence of the migration strategy. Indicators of long distance species which use dominantly farmland and mixed habitat showed significant decline in both of these habitats.

The MMM provided the first relevant information about trends of wintering common bird species in Hungary. Among the investigated 57 species, the trends were classified for 28 species. Nearly 2/3 of the wintering species in Hungary had significant increasing trend and only 4 species had decreasing trends. The available data did not show marked difference in the distribution of these trends between wintering population of species formed mainly from Hungarian populations and wintering population of species formed partly or fully from foreign populations. Based on the existing trend data, the wintering condition probably became more favourable than adverse in Hungary during 2000–2012. Indicators of wintering species, grouped on the basis of habitat occupancy of the Hungarian population in the breeding season showed contradictory results. Indicators of species with farmland and mixed habitat occupancy had increasing trend during the wintering whereas indicators of forest species there was no obvious trend. Indicators of the farmland species had decreasing trend during the breeding season in Hungary and behind the opposite trend of the indicator of farmland habitat during the wintering season, one can expect the influence of the foreign wintering populations, mainly arrive from northern, northeast and east directions to Hungary. These large areas probably covered mainly with non EU member countries, however we have limited information about origin and size of these populations.

We pointed out that long distance migrant bird species had strong decreasing trends in Hungary and very probable in the entire Pannonian biogeographical region, based on the

Hungarian common bird monitoring scheme (MMM), which is the longest running country-wide monitoring using formal sampling design with representative data for the main habitats in Central-Eastern Europe. We showed that partial and short migrant species has increasing trends, in accordance with expectation of effects of climate change (Jiguet *et al.* 2010), which admitted by the increasing trend of common wintering species in Hungary. Beside the climate related effects, that habitat related influences are important factors as well behind the found processes. We pointed out that farmland birds had declining trend, which trend became more obvious since the joining of Hungary to the EU.

Our work show, that negative changes in the farmland habitat could influence bird species nesting/foraging mainly in this habitat independently from their migration strategies. Our results show the increasing importance to monitor the effects of Common Agricultural Policy (CAP) and the efficiency of the mitigation of the adverse effect of the CAP in the frame of Agri-Environmental Schemes (AES) (Butler *et al.* 2010) in Hungary as the modelling of future land-use changes in this region suggest further declines of farmland birds (Schoelfield *et al.* 2011). In concordance with Both *et al.* (2010), our results suggest that long distance migrant species are in most severe condition in highly seasonal habitats. Our investigations of habitat occupancy and preference of the common bird species let us to develop indicators on the base migration strategy and habitat usage of common birds to provide regular data about condition of group of species and their habitat in Hungary and the Pannonian region. The MMM database provide unique opportunity for further investigations of several species, habitats and area specific in a part of Europe where this kind of information is more than rare yet, as several former studies done (Nagy & Szép 2009, Mag *et al.* 2011, Seres *et al.* 2012).

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Table 1. Mean frequency (SE), type of trend with slope (SE) values, habitat occupancy, preference, EBCC PECBMS list for Continental Europe habitat classification and migration strategy of the most common 106 bird species (frequency larger than 5%) during the breeding season between 1999–2012 in Hungary on the base of MMM data. Mean frequency (SE) estimated from the annual frequencies (n=14). Trend type: (–2) steep decline, (–1) moderate decline, (0) stable, (1) moderate increase, (+2) strong increase, (u) uncertain trend. Habitat categories of habitat usage, habitat preference and PECBMS (EBCC): (1) urban, (2) farmland, (3) forest, (4) wetlands, (5) mixed/others. Migration strategies: (1) resident, (2) partial and short distance migrant, (3) long-distance migrant (*: P<0.05, **: P<0.01, # uncertain migration strategy)

1. táblázat A leggyakoribb 106 fészkelő madárfaj átlagos gyakorisága, átlag hibája (SE), a trend típusa és az átlagos éves változás értéke, átlag hibája (SE), élőhely használata, élőhely preferenciája, EBCC PECBMS Kontinentális Európa élőhely klasszifikációja és a vonulási stratégiája a Magyarországon az MMM keretében, a fészkelési időszakban 1999 és 2012 között gyűjtött adatok alapján. Az átlagos gyakoriság az évenként számolt gyakorisági értékek alapján számolva (n=14). Trend típus: (–2) erős csökkenés, (–1) mérsékelt csökkenés, (0) stabil, (1) mérsékelt növekedés, (+2) erős növekedés, (u) bizonytalan trend. Az élőhely használat, preferencia és a PECBMS (EBCC) besorolásnál használt élőhely típusok: (1) urbán, (2) mezőgazdasági, (3) erdei, (4) vizes élőhely, (5) vegyes/egyéb. Vonulási stratégiák: (1) állandó, (2) részlegesen, rövidtávon vonuló, (3) hosszútávon vonuló (*: P<0.05, **: P<0.01, # bizonytalan a vonulási stratégiájú)

Species	Mean frequency		Trend				Habitat			Migration
	(%)	(SE)	type	slope	(SE)		usage	pref.	EBCC	strategy
Phalacrocorax carbo	7.8	0.8	u	0.041	0.076		4	4		2
Botaurus stellaris	6.8	1.1	u	–0.075	0.058		2	4		2
Nycticorax nycticorax	7.6	1.0	u	–0.065	0.059		4	4		3
Egretta alba	19.7	2.2	2	0.242	0.064	**	2	4		2
Ardea cinerea	35.0	1.5	2	0.142	0.031	**	2	4	5	#
Ardea purpurea	5.6	0.4	u	0.026	0.059		5	4		3
Ciconia ciconia	30.2	1.1	u	–0.010	0.021		2	4	2	3
Anser anser	5.8	1.1	u	0.095	0.147		4	4		2
Anas platyrhynchos	44.9	1.7	u	0.026	0.014		5	4	5	2
Circus aeruginosus	43.0	1.2	u	–0.032	0.018		2	4	5	3
Circus pygargus	5.1	0.6	u	0.058	0.240		2	2		3
Accipiter gentilis	6.4	0.4	u	–0.008	0.080		5	3		1
Accipiter nisus	12.6	0.9	u	0.022	0.062		5	3	3	1
Buteo buteo	80.3	1.0	0	0.005	0.011		2	5	5	1
Falco tinnunculus	30.0	1.3	u	–0.021	0.023		2	2	2	2
Falco subbuteo	8.0	0.6	u	0.167	0.083		2	1		3
Perdix perdix	5.4	0.7	–1	–0.107	0.040	**	2	2	2	1
Coturnix coturnix	44.4	1.4	–1	–0.064	0.011	**	2	2		2
Phasianus colchicus	90.8	0.7	0	–0.001	0.006		2	2	5	1
Fulica atra	10.5	0.9	u	0.057	0.034		5	4	5	2
Vanellus vanellus	36.5	1.2	0	0.003	0.013		2	2	2	2
Tringa totanus	10.8	0.8	–1	–0.062	0.030	*	2	4	5	2
Tringa glareola	5.7	1.1	u	–0.093	0.220		2	2		3

Species	Mean frequency		Trend				Habitat			Migration
	(%)	(SE)	type	slope	(SE)		usage	pref.	EBCC	strategy
Larus ridibundus	19.2	1.5	u	0.073	0.044		5	4		2
Columba livia f. domestica	30.0	1.7	u	0.051	0.026		5	1		1
Columba oenas	13.4	1.4	1	0.073	0.035	*	3	3	3	2
Columba palumbus	69.4	1.7	1	0.061	0.010	**	5	5	5	2
Streptopelia decaocto	65.8	0.7	1	0.030	0.006	**	5	1	5	1
Streptopelia turtur	72.7	1.0	0	–0.003	0.007		5	3	2	2
Cuculus canorus	89.6	0.6	–1	–0.021	0.007	**	5	5	5	3
Apus apus	9.1	0.6	u	–0.156	0.370		5	1	5	3
Merops apiaster	27.6	1.3	–1	–0.056	0.028	*	2	2	5	3
Upupa epops	30.3	0.8	u	–0.023	0.015		2	5	5	2
Jynx torquilla	28.2	1.0	1	0.045	0.017	**	5	3	5	3
Picus viridis	23.6	0.9	1	0.057	0.019	**	5	3	3	1
Dryocopos martius	23.3	1.3	u	0.032	0.020		3	3	3	1
Dendrocopos major	57.1	1.2	1	0.016	0.007	*	3	3	5	1
Dendrocopos syriacus	8.5	0.5	–1	–0.081	0.038	*	5	1	5	1
Dendrocopos medius	11.5	0.6	0	–0.001	0.022		3	3	3	1
Dendrocopos minor	9.5	0.8	u	–0.021	0.030		3	3	3	1
Galerida cristata	33.6	1.3	–1	–0.057	0.011	**	2	2	2	1
Lullula arborea	12.6	0.8	–1	–0.078	0.022	**	3	3	5	2
Alauda arvensis	85.1	1.0	–1	–0.023	0.004	**	2	2	2	2
Riparia riparia	9.7	0.7	u	–0.013	0.078		2	4		3
Hirundo rustica	79.2	1.1	–1	–0.070	0.011	**	2	1	2	3
Delichon urbica	42.2	1.5	–1	–0.071	0.018	**	5	1	5	3
Anthus campestris	8.6	1.0	u	–0.021	0.057		2	2	5	3
Anthus trivialis	26.6	1.4	0	–0.017	0.013		5	3	3	3
Anthus pratensis	5.2	0.6	u	0.090	0.103		2	2	2	2
Motacilla flava	45.5	1.2	0	0.008	0.007		2	2	2	3
Motacilla alba	47.1	1.4	0	–0.004	0.009		2	5	5	2
Troglodytes troglodytes	15.6	1.3	u	0.014	0.019		3	3	3	2
Erithacus rubecula	40.8	0.9	1	0.028	0.007	**	3	3	5	2
Luscinia megarhynchos	75.6	0.8	0	0.005	0.005		5	3	5	3
Phoenicurus ochruros	43.1	0.8	1	0.049	0.007	**	5	1	5	2
Saxicola rubetra	24.7	1.2	–1	–0.039	0.018	*	2	5	2	3
Saxicola torquata	63.8	1.1	–1	–0.023	0.008	**	2	4	2	2
Oenanthe oenanthe	12.7	0.6	u	–0.045	0.026		2	5	5	3
Turdus merula	82.9	1.2	1	0.018	0.004	**	5	1	5	2
Turdus philomelos	53.3	2.1	1	0.059	0.007	**	3	3	3	2
Turdus viscivorus	5.5	0.6	u	0.057	0.042		3	3	3	2
Locustella naevia	12.3	1.0	–2	–0.125	0.031	*	2	2	5	3
Locustella fluviatilis	23.7	2.2	–1	–0.072	0.018	**	5	4	5	3
Locustella luscinioides	18.6	1.1	u	–0.032	0.021		4	4		3
Acrocephalus schoenobaenus	27.5	1.5	–1	–0.037	0.015	*	2	4	5	3
Acrocephalus palustris	21.2	0.8	–1	–0.073	0.016	**	2	4	5	3
Acrocephalus scirpaceus	17.0	1.4	–1	–0.030	0.015	*	5	4	5	3

Species	Mean frequency		Trend				Habitat			Migration
	(%)	(SE)	type	slope	(SE)		usage	pref.	EBCC	strategy
Acrocephalus arundinaceus	46.1	1.4	0	–0.002	0.009		2	4	5	3
Hippolais icterina	5.6	0.4	u	–0.076	0.044		5	5	5	3
Sylvia nisoria	18.5	0.9	0	0.010	0.015		2	2	2	3
Sylvia curruca	34.0	1.4	0	–0.010	0.014		5	5	5	3
Sylvia communis	45.6	1.3	–1	–0.023	0.009	**	2	2	2	3
Sylvia borin	8.0	1.3	–2	–0.182	0.036	**	5	5	5	3
Sylvia atricapilla	74.6	1.0	1	0.043	0.004	**	5	3	3	2
Phylloscopus sibilatrix	26.7	2.0	0	0.007	0.014		3	3	3	3
Phylloscopus collybita	59.4	1.3	1	0.010	0.005	*	3	3	3	2
Phylloscopus trochilus	17.3	1.0	0	–0.009	0.016		5	3	3	3
Muscicapa striata	19.4	0.9	–2	–0.090	0.017	*	5	3	3	3
Ficedula albicollis	16.6	1.6	2	0.092	0.018	*	3	3	3	3
Aegithalos caudatus	25.8	1.0	1	0.063	0.015	**	5	3	5	1
Parus palustris	21.0	1.0	1	0.040	0.014	**	3	3	3	1
Parus ater	5.4	0.7	u	0.101	0.057		3	3	3	1
Parus caeruleus	36.6	1.4	1	0.045	0.009	**	3	3	5	2
Parus major	78.8	1.0	1	0.032	0.005	**	5	3	5	2
Sitta europaea	28.7	1.0	1	0.026	0.011	*	3	3	3	1
Certhia brachydactyla	9.5	0.8	u	–0.040	0.031		3	3	3	1
Oriolus oriolus	83.6	0.9	0	0.000	0.006		5	3	5	3
Lanius collurio	73.1	1.7	–1	–0.026	0.007	**	2	2	2	3
Lanius minor	17.7	1.3	–1	–0.054	0.020	**	2	2	2	3
Garrulus glandarius	49.8	1.4	0	0.012	0.009		3	3	3	1
Pica pica	49.3	1.0	1	0.018	0.009	*	2	1	5	1
Corvus frugilegus	21.1	0.9	u	–0.049	0.048		2	5	2	1
Corvus corone cornix	55.1	2.1	1	0.057	0.015	**	2	5	5	1
Corvus corax	24.1	1.5	1	0.110	0.041	*	5	3	5	1
Sturnus vulgaris	91.7	0.9	0	0.016	0.010		2	2	2	2
Passer domesticus	59.7	1.7	–1	–0.023	0.007	**	5	1	5	1
Passer montanus	78.8	0.9	1	0.013	0.007	*	2	1	2	1
Fringilla coelebs	78.7	1.4	1	0.029	0.005	**	3	3	5	2
Serinus serinus	35.3	1.5	–1	–0.031	0.010	**	5	1	5	2
Carduelis chloris	73.4	1.2	1	0.025	0.007	**	5	1	5	2
Carduelis carduelis	71.5	1.1	0	0.015	0.008		2	1	5	2
Carduelis cannabina	24.8	1.2	0	–0.001	0.015		2	1	2	2
Coccothraustres coccothraustes	28.0	1.1	2	0.079	0.014	*	3	3	3	2
Emberiza citrinella	59.0	1.2	0	–0.001	0.005		5	3	2	2
Emberiza schoeniclus	18.0	1.2	1	0.044	0.020	*	5	4	5	2
Miliaria calandra	62.0	1.9	–1	–0.025	0.008	**	2	2	2	1

Table 2. Mean frequency (SE), type of trend with slope (SE) values and source of wintering population of the most common 57 bird species (frequency larger than 5%) during the wintering season between 2000–2012 in Hungary on the base of MMM data. Mean frequency (SE) estimated from the annual frequencies (n=13). Trend type: (–2) steep decline, (–1) moderate decline, (0) stable, (1) moderate increase, (+2) strong increase, (u) uncertain trend. Source of wintering population: (1) formed fully/partly by Hungarian breeding population, (2) formed fully by foreign breeding populations (*: P<0.05, **: P<0.01)

2. táblázat A leggyakoribb 57 telelő madárfaj átlagos gyakorisága, átlag hibája (SE), a trend típusa és az átlagos éves változás értéke, átlag hibája (SE) és a telelő állomány származása a Magyarországon az MMM keretében, a telelési időszakban 2000 és 2012 között gyűjtött adatok alapján. Az átlagos gyakoriság az évenként számolt gyakorisági értékek alapján számolva (n=13). Trend típus: (–2) erős csökkenés, (–1) mérsékelt csökkenés, (0) stabil, (1) mérsékelt növekedés, (+2) erős növekedés, (u) bizonytalan trend. A telelő állomány származása: (1) teljesen vagy részben a magyar állomány, (2) főként külföldön fészkelő állomány (*: P<0.05, **: P<0.01)

Species	Mean frequency		Trend				Wintering
	(%)	(SE)	type	slope	(SE)		population
Phalacrocorax carbo	7.2	0.5	u	0.072	0.052		1
Egretta alba	10.0	0.8	u	–0.015	0.044		1
Ardea cinerea	11.8	1.0	1	0.136	0.058	*	1
Anser fabalis	7.0	1.1	u	0.038	0.154		2
Anser albifrons	8.9	1.9	u	0.228	0.222		2
Anser anser	7.0	1.9	u	0.159	0.377		1
Anas platyrhynchos	18.9	1.7	1	0.135	0.045	**	1
Haliaeetus albicilla	5.4	1.0	u	–0.205	0.118		1
Circus cyaneus	22.3	2.5	u	0.041	0.089		2
Accipiter gentilis	5.6	0.5	u	–0.241	0.136	*	1
Accipiter nisus	26.2	0.9	u	–0.032	0.045		1
Buteo buteo	81.3	1.0	0	0.020	0.011		1
Buteo lagopus	9.5	1.8	u	0.122	0.083		2
Falco tinnunculus	13.7	1.3	u	0.007	0.033		1
Phasianus colchicus	50.3	2.0	–1	–0.033	0.016	*	1
Larus ridibundus	5.9	0.4	u	0.160	0.160		1
Columba livia f. domestica	22.3	1.6	2	0.154	0.044	*	1
Streptopelia decaocto	40.5	1.0	1	0.080	0.023	**	1
Picus viridis	14.8	1.5	1	0.071	0.032	*	1
Dryocopos martius	20.8	2.0	1	0.088	0.035	*	1
Dendrocopos major	58.0	1.1	0	0.010	0.011		1
Dendrocopos syriacus	6.8	1.1	u	0.098	0.075		1
Dendrocopos medius	10.5	0.8	u	0.068	0.039		1
Dendrocopos minor	9.8	1.1	–1	–0.108	0.041	**	1
Galerida cristata	15.9	0.9	u	0.048	0.047		1
Troglodytes troglodytes	25.0	2.0	0	–0.005	0.019		1
Erithacus rubecula	15.2	1.6	u	0.030	0.030		1
Turdus merula	65.8	1.8	0	0.015	0.011		1
Turdus pilaris	55.1	4.2	u	0.004	0.026		2

Species	Mean frequency		Trend				Wintering
	(%)	(SE)	type	slope	(SE)		population
Turdus viscivorus	18.4	1.4	–1	–0.087	0.031	**	1
Regulus regulus	12.5	1.3	u	–0.032	0.036		2
Aegithalos caudatus	28.7	1.4	1	0.048	0.023	*	1
Parus palustris	29.9	1.4	1	0.059	0.021	**	1
Parus ater	6.9	0.9	u	0.056	0.082		1
Parus caeruleus	60.8	1.5	0	0.002	0.013		1
Parus major	88.0	1.3	1	0.038	0.008	**	1
Sitta europaea	33.8	1.1	1	0.028	0.013	*	1
Certhia familiaris	7.3	0.7	–1	–0.015	0.069	*	1
Certhia brachydactyla	11.2	1.3	u	–0.021	0.045		1
Lanius excubitor	24.9	1.1	u	0.008	0.022		2
Garrulus glandarius	51.1	1.5	0	0.008	0.012		1
Pica pica	44.2	1.9	u	0.026	0.014		1
Corvus frugilegus	42.8	1.6	u	–0.045	0.026		2
Corvus corone cornix	40.7	2.4	1	0.094	0.025	**	1
Corvus corax	29.5	1.6	1	0.105	0.039	**	1
Passer domesticus	43.4	2.3	u	–0.021	0.017		1
Passer montanus	60.1	1.5	0	–0.007	0.015		1
Fringilla coelebs	39.3	1.4	2	0.136	0.027	**	1
Fringilla montifringilla	16.8	2.5	u	0.131	0.118		2
Carduelis chloris	55.3	1.4	2	0.106	0.024	*	1
Carduelis carduelis	74.5	1.7	2	0.126	0.025	**	1
Carduelis spinus	13.3	1.8	u	0.090	0.045		2
Carduelis cannabina	21.0	1.4	u	0.052	0.043		1
Pyrrhula pyrrhula	30.4	3.4	1	0.065	0.025	*	2
Coccothraustres coccothraustes	28.7	1.8	1	0.062	0.029	*	1
Emberiza citrinella	34.6	1.3	u	0.057	0.041		1
Emberiza schoeniclus	19.4	2.0	u	0.000	0.040		1

Table 3. Number of species in relation to the habitat occupancy (more than 2/3 of the population occurred in the given habitat in Hungary) and habitat preference (the highest relative density found in the given habitat in Hungary). Only species with more than 5% frequency in Hungary considered

3. táblázat A különböző élőhely használattal (a hazai állomány több, mint 2/3-a az adott élőhely típusban volt felmérve) és élőhely preferenciával (a legnagyobb relatív denzitás az adott élőhely típusban volt) jellemezhető fajok száma. Csak a Magyarországon leggyakoribb fészkelő fajok (átlagos gyakoriság nagyobb, mint 5%) figyelembe véve (élőhelyek: mezőgazdasági, erdei, vizes, vegyes/egyéb)

	Habitat occupancy				
Habitat preference	Farmland	Forest	Wetlands	Mixed	Total
Urban	6	0	0	10	16
Farmland	20	0	0	0	20
Forest	0	21	0	15	36
Wetlands	11	0	4	7	22
Mixed	7	0	0	5	12
Total	**44**	**21**	**4**	**37**	**106**

Supplements of article

Szép T., Nagy K., Nagy Zs., Halmos G. – Population trends of common breeding and wintering birds in Hungary, decline of long-distance migrant and farmland birds during 1999–2012

Supplement 1. Mean frequency (%) with standard error (SE) and observed minimum and maximum annual frequency (%) of the observed 240 bird species during the breeding season between 1999–2012 in Hungary on the base of MMM data. Mean number of annually surveyed 2.5×2.5 km UTM squares with standard deviation (SD) for each species is given. Only UTM squares were considered where the observers was able identify the species by view/song and field survey has carried out following the standard field protocol. Annual frequency was calculated by dividing the number of UTM squares where the given species was seen/heard on the ground/air at randomly selected points of the square with number of all UTM squares surveyed for the given species. Mean and SE estimated from the annual frequencies (n=14)

Melléklet 1. A megfigyelt 240 madárfaj átlagos gyakorisága (%), átlag hibája (SE), a megfigyelt éves gyakoriság minimum és maximum értékei (%) a Magyarországon az MMM keretében, a fészkelési időszakban 1999 és 2012 között gyűjtött adatok alapján. Az átlagosan évente felmért 2,5×2,5 km UTM négyzetek száma, az átlag szórása (SD) fajonként megadva. Csak azon UTM négyzetek figyelembe véve, ahol a felmérő látvány és/vagy hang alapján azonosítani tudta az adott fajt és a felmérés az MMM standard protokollja alapján történt. Éves gyakoriság azon UTM négyzetek hányadosa alapján megállapítva, ahol az adott fajt látták/hallották az UTM négyzeten belül lévő random elhelyezkedő megfigyelési pontokon a földön/növényzeten/repülve, osztva azon UTM négyzetekkel, ahol az adott faj jelenlétét/hiányát vizsgálták. Az átlagos gyakoriságot és az átlag hibáját (SE) az évenként számolt gyakorisági értékek alapján számolva (n=14)

Species	Mean frequency (%)	(SE)	Observed minimum annual frequency (%)	Observed maximum annual frequency (%)	Mean # of annually surveyed UTM squares	(SD)
Tachybaptus ruficollis	2.5	0.5	0.0	7.8	111	21.8
Podiceps cristatus	3.0	0.3	1.5	5.9	148	30.8
Podiceps grisegena	0.1	0.1	0.0	1.3	85	23.4
Podiceps nigricollis	0.6	0.2	0.0	1.7	95	21.9
Phalacrocorax carbo	7.8	0.8	4.4	15.1	157	28.7
Phalacrocorax pygmeus	0.9	0.5	0.0	6.3	97	20.2
Botaurus stellaris	6.8	1.1	1.2	19.1	143	25.8
Ixobrychus minutus	1.6	0.2	0.0	3.0	125	22.7
Nycticorax nycticorax	7.6	1.0	4.7	19.0	150	26.2
Ardeola ralloides	0.8	0.5	0.0	6.5	101	21.9
Egretta garzetta	3.2	0.5	0.5	7.4	147	26.2
Egretta alba	19.7	2.2	11.0	42.9	153	27.4
Ardea cinerea	35.0	1.5	28.1	47.2	158	28.4
Ardea purpurea	5.6	0.4	3.4	7.8	141	26.5
Bubulcus ibis	0.1	0.1	0.0	0.9	102	22.9
Ciconia nigra	4.7	0.8	1.8	12.9	159	28.8
Ciconia ciconia	30.2	1.1	23.4	35.9	161	29.1
Plegadis falcinellus	0.0	0.0	0.0	0.7	116	26.4
Platalea leucorodia	3.1	0.9	0.0	12.4	153	29.3

Species	Mean frequency (%)	(SE)	Observed minimum annual frequency (%)	Observed maximum annual frequency (%)	Mean # of annually surveyed UTM squares	(SD)
Cygnus olor	3.1	0.5	0.6	7.1	152	25.4
Cygnus cygnus	0.0	0.0	0.0	0.7	125	20.3
Anser fabalis	0.1	0.1	0.0	0.9	126	23.7
Anser albifrons	0.1	0.1	0.0	0.8	106	17.6
Anser anser	5.8	1.1	1.6	15.2	139	25.9
Tadorna tadorna	0.3	0.1	0.0	1.1	98	18.3
Anas penelope	0.3	0.2	0.0	2.6	90	17.4
Anas strepera	0.5	0.2	0.0	2.5	82	18.4
Anas crecca	0.4	0.2	0.0	2.1	111	24.8
Anas platyrhynchos	44.9	1.7	39.3	62.9	159	28.6
Anas acuta	0.1	0.1	0.0	1.2	98	21.9
Anas querquedula	4.2	0.8	0.0	9.7	110	24.9
Anas clypeata	1.1	0.3	0.0	3.4	129	26.5
Netta rufina	0.1	0.1	0.0	1.1	93	17.3
Aythya ferina	3.2	0.7	0.0	10.4	127	25.1
Aythya nyroca	2.3	0.6	0.0	8.8	130	26.4
Aythya fuligula	0.3	0.1	0.0	1.4	110	23.5
Bucephala clangula	0.1	0.1	0.0	1.1	103	25.1
Mergus albellus	0.1	0.1	0.0	0.9	81	17.6
Mergus merganser	0.2	0.1	0.0	1.4	83	16.8
Pernis apivorus	2.0	0.3	0.0	3.5	95	21.5
Milvus migrans	1.5	0.3	0.0	3.5	127	25.8
Milvus milvus	0.2	0.1	0.0	1.0	116	25.2
Haliaeetus albicilla	2.4	0.5	0.7	7.6	134	26.2
Circaetus gallicus	0.2	0.2	0.0	1.9	86	19.8
Circus aeruginosus	43.0	1.2	38.5	52.6	146	25.7
Circus cyaneus	1.5	0.3	0.0	3.1	104	19.3
Circus macrourus	0.3	0.2	0.0	2.0	79	18.4
Circus pygargus	5.1	0.6	0.9	8.9	106	21.5
Accipiter gentilis	6.4	0.4	4.7	9.6	145	27.6
Accipiter nisus	12.6	0.9	7.6	18.9	146	24.9
Buteo buteo	80.3	1.0	74.3	87.1	158	28.9
Buteo rufinus	0.1	0.1	0.0	1.5	64	17.4
Buteo lagopus	0.1	0.1	0.0	0.9	117	20.0
Aquila pomarina	0.2	0.2	0.0	2.0	64	15.1
Aquila heliaca	2.1	0.4	0.0	4.7	110	20.7
Hieraaetus pennatus	0.2	0.2	0.0	2.9	49	14.1
Pandion haliaetus	0.2	0.1	0.0	1.3	113	28.2
Falco tinnunculus	30.0	1.3	21.2	37.5	152	26.8
Falco vespertinus	4.2	0.6	0.8	8.6	141	26.3
Falco columbarius	0.2	0.1	0.0	1.1	74	13.9
Falco subbuteo	8.0	0.6	5.4	12.4	122	24.3
Falco cherrug	1.4	0.1	0.7	2.4	122	26.9
Falco peregrinus	0.9	0.2	0.0	2.4	118	24.3
Perdix perdix	5.4	0.7	0.6	9.3	150	27.7

Species	Mean frequency (%)	(SE)	Observed minimum annual frequency (%)	Observed maximum annual frequency (%)	Mean # of annually surveyed UTM squares	(SD)
Coturnix coturnix	44.4	1.4	33.3	52.2	154	28.5
Phasianus colchicus	90.8	0.7	85.7	94.9	161	28.6
Rallus aquaticus	1.7	0.6	0.0	8.9	107	22.7
Porzana porzana	0.3	0.3	0.0	4.5	64	15.1
Porzana parva	0.7	0.4	0.0	4.5	62	13.8
Crex crex	2.6	0.6	0.0	7.2	121	22.4
Gallinula chloropus	4.4	0.5	0.8	7.6	137	24.6
Fulica atra	10.5	0.9	5.8	17.4	155	29.2
Grus grus	1.6	0.2	0.0	3.0	153	27.9
Otis tarda	0.6	0.1	0.0	1.5	155	28.7
Himantopus himantopus	1.5	0.2	0.0	3.5	130	27.0
Recurvirostra avosetta	1.0	0.2	0.0	2.0	145	31.8
Burhinus oedicnemus	0.2	0.1	0.0	1.0	110	25.0
Glareola pratincola	0.7	0.2	0.0	1.8	96	19.8
Charadrius dubius	3.3	0.4	0.9	5.6	84	20.5
Charadrius hiaticula	0.2	0.1	0.0	1.4	66	13.9
Charadrius alexandrinus	0.1	0.1	0.0	1.2	78	16.8
Vanellus vanellus	36.5	1.2	30.4	49.6	158	29.6
Calidris minuta	0.3	0.2	0.0	2.2	50	12.8
Calidris alpina	0.1	0.1	0.0	2.0	45	11.1
Philomachus pugnax	3.0	0.4	1.3	6.3	105	24.6
Gallinago gallinago	2.4	0.6	0.0	9.1	115	19.7
Gallinago media	0.1	0.1	0.0	1.4	69	15.4
Scolopax rusticola	0.1	0.1	0.0	1.1	122	21.4
Limosa limosa	3.0	0.5	0.0	6.4	105	24.0
Numenius phaeopus	0.9	0.2	0.0	2.1	73	16.2
Numenius arquata	1.7	0.3	0.0	4.0	102	21.9
Tringa erythropus	1.4	0.4	0.0	3.4	62	15.5
Tringa totanus	10.8	0.8	6.1	14.9	112	24.6
Tringa stagnatilis	0.2	0.2	0.0	2.2	45	12.2
Tringa nebularia	1.1	0.4	0.0	4.7	57	13.2
Tringa ochropus	1.3	0.3	0.0	4.3	70	14.9
Tringa glareola	5.7	1.1	0.0	15.9	66	13.3
Actitis hypoleucos	2.6	0.5	0.0	6.9	93	17.5
Arenaria interpres	0.1	0.1	0.0	1.2	84	19.9
Larus melanocephalus	0.6	0.2	0.0	2.2	82	19.6
Larus minutus	0.3	0.2	0.0	2.6	46	10.5
Larus ridibundus	19.2	1.5	11.2	28.9	151	28.3
Larus canus	0.3	0.2	0.0	1.8	52	11.9
Larus fuscus	0.2	0.2	0.0	2.1	41	14.3
Larus argentatus	0.6	0.3	0.0	3.0	87	20.4
Larus cachinnans	4.3	0.8	0.0	10.5	61	13.5
Sterna caspia	0.1	0.1	0.0	1.4	73	16.1
Sterna hirundo	2.3	0.3	0.8	4.1	111	21.7
Chlidonias hybridus	3.8	1.2	0.0	17.5	83	20.0

Species	Mean frequency (%)	(SE)	Observed minimum annual frequency (%)	Observed maximum annual frequency (%)	Mean # of annually surveyed UTM squares	(SD)
Chlidonias niger	2.8	0.5	0.0	6.6	92	21.2
Chlidonias leucopterus	1.5	0.8	0.0	11.4	71	18.5
Columba livia f. domestica	30.0	1.7	12.3	38.1	107	16.0
Columba oenas	13.4	1.4	5.5	25.6	126	26.1
Columba palumbus	69.4	1.7	58.8	82.1	155	26.8
Streptopelia decaoto	65.8	0.7	62.1	71.9	161	28.9
Streptopelia turtur	72.7	1.0	63.7	77.1	155	27.1
Cuculus canorus	89.6	0.6	85.6	93.7	160	28.2
Otus scops	0.2	0.1	0.0	1.3	110	24.5
Bubo bubo	0.1	0.1	0.0	0.8	144	29.3
Athene noctua	1.4	0.4	0.0	5.4	147	28.7
Strix aluco	1.9	0.4	0.0	5.1	135	26.3
Asio otus	1.4	0.2	0.5	3.0	152	28.0
Asio flammeus	0.3	0.2	0.0	2.3	110	20.3
Caprimulgus europaeus	0.6	0.2	0.0	2.5	131	24.2
Apus apus	9.1	0.6	5.7	12.8	151	29.7
Alcedo atthis	2.8	0.5	0.6	7.4	156	28.9
Merops apiaster	27.6	1.3	18.8	35.7	159	29.4
Coracias garrulus	3.2	0.5	0.0	8.1	147	29.2
Upupa epops	30.3	0.8	25.4	35.9	160	29.0
Jynx torquilla	28.2	1.0	18.7	33.7	142	27.4
Picus canus	3.7	0.7	0.8	9.1	115	20.6
Picus viridis	23.6	0.9	18.6	28.5	156	26.7
Dryocopos martius	23.3	1.3	17.3	31.9	157	27.9
Dendrocopos major	57.1	1.2	51.1	64.7	155	25.8
Dendrocopos syriacus	8.5	0.5	6.3	12.1	141	24.8
Dendrocopos medius	11.5	0.6	7.8	15.4	138	24.6
Dendrocopos leucotos	0.8	0.2	0.0	2.4	112	21.1
Dendrocopos minor	9.5	0.8	4.4	14.6	148	23.4
Calandrella brachydactyla	0.5	0.3	0.0	3.0	62	16.0
Galerida cristata	33.6	1.3	24.3	39.5	158	28.5
Lullula arborea	12.6	0.8	6.9	16.3	108	18.8
Alauda arvensis	85.1	1.0	79.4	89.4	159	28.6
Riparia riparia	9.7	0.7	4.2	13.4	150	30.1
Hirundo rustica	79.2	1.1	68.3	83.8	160	29.2
Delichon urbica	42.2	1.5	32.0	49.3	159	28.2
Anthus campestris	8.6	1.0	4.1	15.8	75	16.1
Anthus trivialis	26.6	1.4	17.1	34.2	105	18.6
Anthus pratensis	5.2	0.6	2.3	10.9	70	12.7
Anthus cervinus	1.3	0.6	0.0	7.3	48	12.6
Anthus spinoletta	0.2	0.2	0.0	2.9	41	10.7
Motacilla flava	45.5	1.2	37.7	50.3	149	26.9
Motacilla citreola	0.1	0.1	0.0	1.0	70	11.6
Motacilla cinerea	1.6	0.3	0.0	4.5	115	22.1
Motacilla alba	47.1	1.4	40.4	57.5	160	29.3

Species	Mean frequency (%)	(SE)	Observed minimum annual frequency (%)	Observed maximum annual frequency (%)	Mean # of annually surveyed UTM squares	(SD)
Bombycilla garrulus	0.2	0.1	0.0	1.7	149	24.6
Cinclus cinclus	0.1	0.1	0.0	1.3	131	27.8
Troglodytes troglodytes	15.6	1.3	8.9	23.9	156	25.6
Prunella modularis	2.7	0.4	0.0	6.0	107	23.9
Erithacus rubecula	40.8	0.9	36.3	45.8	159	27.7
Luscinia luscinia	0.8	0.3	0.0	3.2	102	23.5
Luscinia megarhynchos	75.6	0.8	68.5	81.2	157	28.1
Luscinia svecica	1.5	0.5	0.0	5.5	141	26.8
Phoenicurus ochruros	43.1	0.8	35.9	48.7	159	27.8
Phoenicurus phoenicurus	2.6	0.4	0.0	5.6	151	27.5
Saxicola rubetra	24.7	1.2	15.0	29.6	131	26.6
Saxicola torquata	63.8	1.1	56.2	70.6	151	27.5
Oenanthe oenanthe	12.7	0.6	9.2	16.4	121	23.5
Turdus merula	82.9	1.2	75.5	89.4	161	28.9
Turdus pilaris	1.4	0.2	0.6	3.0	148	22.2
Turdus philomelos	53.3	2.1	41.8	64.0	151	24.9
Turdus iliacus	0.1	0.1	0.0	1.0	118	25.2
Turdus viscivorus	5.5	0.6	1.8	9.5	121	23.2
Locustella naevia	12.3	1.0	6.5	20.0	102	17.5
Locustella fluviatilis	23.7	2.2	8.9	38.9	115	18.7
Locustella luscinioides	18.6	1.1	12.9	30.0	117	22.1
Acrocephalus melanopogon	1.1	0.4	0.0	4.4	84	15.3
Acrocephalus paludicola	0.3	0.2	0.0	3.0	93	17.3
Acrocephalus schoenobaenus	27.5	1.5	18.7	40.6	99	20.7
Acrocephalus palustris	21.2	0.8	14.0	26.4	103	19.3
Acrocephalus scirpaceus	17.0	1.4	8.0	25.8	116	19.6
Acrocephalus arundinaceus	46.1	1.4	34.7	55.7	147	28.6
Hippolais pallida	0.2	0.2	0.0	1.6	51	11.7
Hippolais icterina	5.6	0.4	2.4	8.6	89	13.8
Sylvia nisoria	18.5	0.9	15.0	26.2	117	26.5
Sylvia curruca	34.0	1.4	27.8	43.0	101	21.8
Sylvia communis	45.6	1.3	35.1	52.9	123	24.9
Sylvia borin	8.0	1.3	3.0	16.0	105	18.4
Sylvia atricapilla	74.6	1.0	67.8	79.6	151	26.6
Phylloscopus sibilatrix	26.7	2.0	11.9	41.7	107	18.8
Phylloscopus collybita	59.4	1.3	50.9	69.4	147	25.4
Phylloscopus trochilus	17.3	1.0	11.8	23.0	110	19.2
Regulus regulus	2.1	0.3	0.7	5.2	139	25.8
Regulus ignicapellus	0.5	0.2	0.0	2.1	137	27.1
Muscicapa striata	19.4	0.9	15.7	25.2	122	26.3
Ficedula parva	0.9	0.2	0.0	2.2	103	20.5
Ficedula albicollis	16.6	1.6	7.2	27.5	129	25.0
Ficedula hypoleuca	2.6	0.4	0.0	5.4	127	24.0
Panurus biarmicus	1.8	0.4	0.0	4.9	138	26.7
Aegithalos caudatus	25.8	1.0	21.5	31.9	158	27.1

Species	Mean frequency (%)	(SE)	Observed minimum annual frequency (%)	Observed maximum annual frequency (%)	Mean # of annually surveyed UTM squares	(SD)
Parus palustris	21.0	1.0	15.9	27.5	150	25.4
Parus montanus	1.3	0.3	0.0	4.1	104	18.2
Parus cristatus	0.8	0.2	0.0	2.1	143	26.2
Parus ater	5.4	0.7	1.9	10.6	132	21.3
Parus caeruleus	36.6	1.4	25.3	43.0	160	28.4
Parus major	78.8	1.0	73.6	86.7	161	28.9
Sitta europaea	28.7	1.0	21.0	35.5	156	27.6
Certhia familiaris	4.0	0.7	0.0	8.8	81	13.8
Certhia brachydactyla	9.5	0.8	4.2	13.7	97	16.2
Remiz pendulinus	3.7	0.4	0.9	6.1	141	28.2
Oriolus oriolus	83.6	0.9	77.1	88.5	159	28.8
Lanius collurio	73.1	1.7	55.9	79.1	157	28.4
Lanius minor	17.7	1.3	10.3	24.2	130	28.5
Lanius exubitor	1.4	0.4	0.0	4.8	140	26.6
Garrulus glandarius	49.8	1.4	42.3	56.8	159	28.6
Pica pica	49.3	1.0	42.8	55.8	161	29.2
Corvus monedula	4.3	0.5	1.6	7.8	158	28.0
Corvus frugilegus	21.1	0.9	15.8	28.6	161	28.6
Corvus corone cornix	55.1	2.1	39.0	65.7	159	28.5
Corvus corax	24.1	1.5	14.2	35.9	159	27.6
Sturnus vulgaris	91.7	0.9	86.5	96.5	161	28.5
Sturnus roseus	0.1	0.1	0.0	1.0	101	25.6
Passer domesticus	59.7	1.7	44.0	68.1	161	29.3
Passer montanus	78.8	0.9	73.3	83.5	160	28.3
Fringilla coelebs	78.7	1.4	72.1	87.1	157	28.1
Fringilla montifringilla	0.5	0.2	0.0	1.4	134	22.1
Serinus serinus	35.3	1.5	26.5	44.1	144	25.3
Carduelis chloris	73.4	1.2	66.5	82.1	158	28.5
Carduelis carduelis	71.5	1.1	66.9	80.2	159	28.2
Carduelis spinus	2.2	0.5	0.7	5.2	138	25.7
Carduelis cannabina	24.8	1.2	19.9	32.6	138	22.6
Carduelis flammea	0.2	0.1	0.0	1.7	103	21.0
Loxia curvirostra	0.6	0.2	0.0	1.9	145	26.9
Pyrrhula pyrrhula	0.8	0.1	0.0	2.2	150	25.6
Coccothraustres coccothraustes	28.0	1.1	21.3	35.1	158	27.0
Emberiza citrinella	59.0	1.2	52.2	65.9	151	27.8
Emberiza cirlus	0.1	0.1	0.0	1.1	71	15.9
Emberiza cia	1.5	0.3	0.0	2.9	97	18.1
Emberiza hortulana	0.4	0.2	0.0	2.1	77	15.8
Emberiza schoeniclus	18.0	1.2	11.8	28.8	117	21.3
Miliaria calandra	62.0	1.9	51.4	76.2	141	23.3

Supplement 2. Mean frequency (%) with standard error (SE) and observed minimum and maximum annual frequency (%) of the surveyed 140 bird species during the wintering season between 2000–2012 in Hungary on the base of MMM data. Mean number of annually surveyed 2.5×2.5 km UTM squares with standard deviation (SD) for each species is given. Only UTM squares were considered where the observers was able identify the species by view/song and field survey has carried out following the standard field protocol. Annual frequency was calculated by dividing the number of UTM squares where the given species was seen/heard on the ground/air at randomly selected points of the square with number of all UTM squares surveyed for the given species. Mean and SE estimated from the annual frequencies (n=13)

Melléklet 2. A megfigyelt 140 madárfaj átlagos gyakorisága (%), átlag hibája (SE), a megfigyelt éves gyakoriság minimum és maximum értékei (%) a Magyarországon az MMM keretében, a telelési időszakban 2000 és 2012 között gyűjtött adatok alapján. Az átlagosan évente felmért 2,5×2,5 km UTM négyzetek száma, az átlag szórása (SD) fajonként megadva. Csak azon UTM négyzetek figyelembe véve, ahol a felmérő látvány és/vagy hang alapján azonosítani tudta az adott fajt és a felmérés az MMM standard protokollja alapján történt. Éves gyakoriság azon UTM négyzetek hányadosa alapján megállapítva, ahol az adott fajt látták/hallották az UTM négyzeten belül lévő random elhelyezkedő megfigyelési pontokon a földön/növényzeten/repülve, osztva azon UTM négyzetekkel, ahol az adott faj jelenlétét/hiányát vizsgálták. Az átlagos gyakoriságot és az átlag hibáját (SE) az évenként számolt gyakorisági értékek alapján számolva (n=13)

Species	Mean frequency (%)	(SE)	Observed minimum annual frequency (%)	Observed maximum annual frequency (%)	Mean # of annually surveyed UTM squares	(SD)
Tachybaptus ruficollis	2.1	0.4	0.0	4.1	70	15.5
Phalacrocorax carbo	7.2	0.5	4.3	10.0	99	22.6
Botaurus stellaris	0.4	0.2	0.0	2.3	89	20.7
Egretta alba	10.0	0.8	6.1	14.4	97	21.9
Ardea cinerea	11.8	1.0	7.8	19.0	99	22.3
Cygnus olor	2.7	0.6	0.8	8.0	97	22.9
Cygnus cygnus	0.2	0.2	0.0	2.5	82	19.2
Anser fabalis	7.0	1.1	2.2	13.0	78	17.7
Anser albifrons	8.9	1.9	2.5	25.6	70	16.3
Anser anser	7.0	1.9	0.0	21.2	88	19.5
Branta ruficollis	0.3	0.3	0.0	3.3	57	12.8
Anas penelope	0.2	0.1	0.0	1.4	58	13.7
Anas crecca	2.1	0.5	0.0	6.2	68	14.5
Anas platyrhynchos	18.9	1.7	12.1	30.2	101	22.4
Anas acuta	0.2	0.2	0.0	2.7	61	11.5
Aythya ferina	1.4	0.3	0.0	2.6	80	16.7
Aythya nyroca	0.2	0.1	0.0	1.3	79	17.1
Aythya fuligula	0.9	0.3	0.0	2.6	68	13.9
Somaterina mollissima	0.2	0.2	0.0	3.0	48	10.0
Bucephala clangula	3.2	0.5	0.0	6.8	63	12.7
Mergus albellus	0.5	0.4	0.0	4.7	49	12.3
Mergus merganser	0.6	0.2	0.0	2.1	52	11.2
Milvus milvus	0.1	0.1	0.0	1.2	74	16.0
Haliaeetus albicilla	5.4	1.0	1.3	12.9	84	19.3

Species	Mean frequency (%)	(SE)	Observed minimum annual frequency (%)	Observed maximum annual frequency (%)	Mean # of annually surveyed UTM squares	(SD)
Circus aeruginosus	2.0	0.5	0.0	5.1	92	20.0
Circus cyaneus	22.3	2.5	9.5	40.8	67	15.6
Accipiter gentilis	5.6	0.5	2.8	9.9	92	21.0
Accipiter nisus	26.2	0.9	21.0	30.9	93	21.9
Buteo buteo	81.3	1.0	74.8	87.2	101	22.2
Buteo rufinus	0.1	0.1	0.0	1.8	40	8.5
Buteo lagopus	9.5	1.8	2.4	20.2	76	17.8
Aquila clanga	0.3	0.3	0.0	4.2	35	7.7
Aquila heliaca	2.3	0.6	0.0	6.3	70	15.8
Aquila chrysaetos	0.2	0.2	0.0	1.7	58	11.2
Falco tinnunculus	13.7	1.3	6.5	21.9	97	21.6
Falco columbarius	3.2	0.6	0.0	7.4	48	12.1
Falco cherrug	0.8	0.4	0.0	5.0	74	16.5
Falco peregrinus	1.4	0.3	0.0	3.5	73	17.2
Perdix perdix	1.6	0.3	0.0	3.7	96	21.3
Coturnix coturnix	0.1	0.1	0.0	1.0	97	21.5
Phasianus colchicus	50.3	2.0	44.1	64.1	101	22.8
Rallus aquaticus	0.1	0.1	0.0	1.2	66	14.3
Gallinula chloropus	0.2	0.2	0.0	2.3	88	19.9
Fulica atra	1.5	0.2	0.0	2.8	97	20.9
Grus grus	0.7	0.3	0.0	4.0	97	22.5
Otis tarda	0.3	0.2	0.0	1.9	97	21.2
Vanellus vanellus	0.1	0.1	0.0	0.9	99	21.9
Gallinago gallinago	0.1	0.1	0.0	1.1	72	16.5
Scolopax rusticola	0.1	0.1	0.0	1.2	79	17.4
Tringa ochropus	0.3	0.2	0.0	2.6	41	10.2
Larus ridibundus	5.9	0.4	3.6	8.1	94	20.7
Larus canus	3.4	1.0	0.0	11.4	32	9.0
Larus fuscus	0.4	0.4	0.0	5.6	24	5.6
Larus argentatus	0.6	0.4	0.0	4.3	53	10.5
Larus cachinnans	3.2	1.1	0.0	12.5	39	9.9
Columba livia f. domestica	22.3	1.6	7.1	30.5	70	18.6
Columba oenas	4.7	0.8	1.4	10.5	78	19.6
Columba palumbus	0.9	0.2	0.0	3.0	98	22.0
Streptopelia decaoto	40.5	1.0	34.4	44.3	101	22.4
Streptopelia turtur	0.2	0.2	0.0	3.2	98	22.3
Tyto alba	0.1	0.1	0.0	1.1	94	20.7
Athene noctua	0.4	0.2	0.0	1.5	92	19.9
Strix aluco	0.7	0.2	0.0	2.3	84	18.1
Strix uralensis	0.3	0.2	0.0	2.0	56	11.1
Asio otus	1.6	0.3	0.0	3.3	96	22.0
Asio flammeus	0.8	0.5	0.0	5.8	69	15.8
Alcedo atthis	1.1	0.2	0.0	2.2	98	21.3
Picus canus	2.9	0.8	0.0	9.2	73	16.9
Picus viridis	14.8	1.5	5.9	26.2	98	22.1

Species	Mean frequency (%)	(SE)	Observed minimum annual frequency (%)	Observed maximum annual frequency (%)	Mean # of annually surveyed UTM squares	(SD)
Dryocopos martius	20.8	2.0	11.8	32.1	99	22.5
Dendrocopos major	58.0	1.1	51.8	66.7	98	23.3
Dendrocopos syriacus	6.8	1.1	1.8	13.5	89	21.1
Dendrocopos medius	10.5	0.8	5.4	14.6	86	19.6
Dendrocopos leucotos	0.4	0.2	0.0	1.2	70	16.7
Dendrocopos minor	9.8	1.1	3.5	15.2	94	22.2
Galerida cristata	15.9	0.9	11.4	20.5	100	22.8
Lullula arborea	0.1	0.1	0.0	1.1	69	15.8
Alauda arvensis	2.4	0.6	0.0	8.2	100	22.4
Eremophila alpestris	0.4	0.4	0.0	4.8	30	7.5
Anthus pratensis	2.0	0.7	0.0	8.3	46	9.9
Anthus spinoletta	1.9	1.4	0.0	18.4	26	6.0
Motacilla cinerea	0.1	0.1	0.0	1.3	72	14.8
Motacilla alba	0.6	0.2	0.0	2.0	101	21.9
Bombycilla garrulus	1.8	0.8	0.0	7.7	94	21.6
Troglodytes troglodytes	25.0	2.0	14.4	38.0	99	22.7
Prunella modularis	1.0	0.3	0.0	2.9	67	15.4
Erithacus rubecula	15.2	1.6	2.2	25.5	99	22.4
Phoenicurus ochruros	0.7	0.3	0.0	2.9	101	22.4
Saxicola torquata	0.1	0.1	0.0	1.0	93	19.9
Turdus merula	65.8	1.8	54.2	76.3	101	22.7
Turdus pilaris	55.1	4.2	25.7	73.8	95	22.7
Turdus philomelos	3.5	0.8	0.9	10.0	95	20.7
Turdus iliacus	3.5	0.9	0.0	10.9	75	16.1
Turdus viscivorus	18.4	1.4	10.3	27.8	74	15.0
Sylvia atricapilla	0.2	0.1	0.0	1.1	94	19.6
Phylloscopus collybita	0.1	0.1	0.0	1.0	92	20.0
Regulus regulus	12.5	1.3	4.3	20.6	88	19.3
Regulus ignicapellus	0.6	0.3	0.0	2.5	87	17.8
Panurus biarmicus	1.1	0.4	0.0	5.1	87	18.9
Aegithalos caudatus	28.7	1.4	18.4	34.9	101	22.8
Parus palustris	29.9	1.4	19.4	39.6	95	22.2
Parus montanus	2.0	0.5	0.0	5.0	68	16.9
Parus cristatus	0.9	0.2	0.0	2.1	90	19.8
Parus ater	6.9	0.9	2.4	12.2	83	19.4
Parus caeruleus	60.8	1.5	47.6	70.6	101	22.7
Parus major	88.0	1.3	80.9	95.8	101	22.6
Sitta europaea	33.8	1.1	26.0	42.7	99	22.9
Certhia familiaris	7.3	0.7	3.4	12.5	51	12.5
Certhia brachydactyla	11.2	1.3	4.2	19.4	64	18.3
Remiz pendulinus	0.8	0.4	0.0	5.0	88	18.4
Lanius exubitor	24.9	1.1	19.2	32.2	89	19.6
Garrulus glandarius	51.1	1.5	41.4	58.5	101	22.2
Pica pica	44.2	1.9	32.3	54.0	101	22.9
Nucifraga caryocatactes	0.1	0.1	0.0	1.6	69	14.4

Species	Mean frequency (%)	(SE)	Observed minimum annual frequency (%)	Observed maximum annual frequency (%)	Mean # of annually surveyed UTM squares	(SD)
Corvus monedula	4.2	0.6	1.7	8.9	99	23.1
Corvus frugilegus	42.8	1.6	36.1	56.0	101	22.9
Corvus corone cornix	40.7	2.4	28.3	52.2	100	22.8
Corvus corax	29.5	1.6	20.2	37.2	100	23.0
Sturnus vulgaris	3.4	0.8	0.0	9.8	101	22.7
Passer domesticus	43.4	2.3	33.0	59.0	102	22.6
Passer montanus	60.1	1.5	50.5	68.6	101	22.7
Fringilla coelebs	39.3	1.4	29.8	47.3	98	21.4
Fringilla montifringilla	16.8	2.5	3.9	39.2	85	17.8
Serinus serinus	0.8	0.3	0.0	3.0	91	19.3
Carduelis chloris	55.3	1.4	48.4	65.9	99	22.9
Carduelis carduelis	74.5	1.7	66.4	84.3	100	22.1
Carduelis spinus	13.3	1.8	3.7	26.9	85	18.1
Carduelis cannabina	21.0	1.4	13.9	30.3	89	19.2
Carduelis flavirostris	0.7	0.5	0.0	6.5	40	9.7
Carduelis flammea	0.9	0.3	0.0	2.7	64	12.6
Loxia curvirostra	1.2	0.8	0.0	10.8	90	19.1
Pyrrhula pyrrhula	30.4	3.4	16.7	54.4	95	21.0
Coccothraustres coccothraustes	28.7	1.8	20.7	43.8	99	22.9
Calcarius lapponicus	0.4	0.4	0.0	5.0	30	8.5
Plectrophenax nivalis	0.7	0.3	0.0	2.9	57	13.5
Emberiza citrinella	34.6	1.3	26.0	40.2	94	20.1
Emberiza cirlus	0.5	0.3	0.0	2.3	44	8.0
Emberiza cia	0.1	0.1	0.0	1.5	60	12.2
Emberiza schoeniclus	19.4	2.0	11.8	32.4	74	17.2
Miliaria calandra	4.6	0.8	1.1	12.1	88	20.2

Supplement 3. Relative density (individual/km^2) in the main habitat types (mean, SE and number of points considered), habitat occupancy of the surveyed population in the main habitat types (% of the estimated population in the given habitat compared to the entire population) and number of estimated individuals of the given species on the base of the relative density and area of habitat types in Hungary, using data collected between 1999–2012 following the MMM standard protocol in Hungary

Melléklet 3. Az MMM keretében 1999–2012 során megfigyelt fészkelő madárfajok relatív denzitása (egyed/km^2) a fő élőhely típusokban (urbán, mezőgazdasági, erdei, vizes) (átlag, átlag hibája (SE) , a megfigyelt pontok száma), élőhely használata (az adott élőhelyen megfigyelt állomány aránya (%) a négy fő élőhelyen becsült állományhoz képest), a négy fő élőhelyen együttesen élő egyedek számának becslése a fő élőhelyeken becsült relatív denzitás és az adott élőhely magyarországi kiterjedése alapján

Species	Relative density (individual/km²)													Habitat occupancy (%)			Estimated
	Urban	SE	n	Farmland	SE	n	Forest	SE	n	Wetlands	SE	n	Urban	Farmland	Forest	Wetlands	# of ind.
Tachybaptus ruficollis	0.000	0.000	577	0.100	0.043	5 294	0.030	0.022	1 601	0.363	0.194	137	0.0	78.1	7.4	14.5	8 239
Podiceps cristatus	0.118	0.118	811	0.043	0.017	6 716	0.011	0.011	1 973	3.152	1.666	156	4.7	19.6	1.6	74.2	14 003
Podiceps nigricollis	0.000	0.000	491	0.001	0.001	4 639	0.000	0.000	1 219	0.263	0.160	125	0.0	7.3	0.0	92.7	935
Phalacrocorax carbo	0.000	0.000	843	0.008	0.003	6 965	0.025	0.012	2 128	0.581	0.306	157	0.0	17.7	17.4	64.9	2 945
Phalacrocorax pygmeus	0.030	0.030	533	0.008	0.005	5 039	0.000	0.000	1 434	0.921	0.799	121	4.5	13.2	0.0	82.2	3 688
Botaurus stellaris	0.000	0.000	755	0.147	0.025	6 625	0.010	0.008	1 933	1.069	0.364	152	0.0	71.7	1.5	26.8	13 151
Ixobrychus minutus	0.035	0.025	663	0.013	0.008	5 873	0.000	0.000	1 697	1.006	0.520	144	4.5	19.4	0.0	76.1	4 357
Nycticorax nycticorax	0.085	0.053	747	0.105	0.048	6 709	0.005	0.004	2 056	4.710	3.098	150	2.1	29.5	0.4	67.9	22 844
Ardeola ralloides	0.000	0.000	516	0.014	0.009	4 999	0.000	0.000	1 384	0.522	0.367	122	0.0	34.4	0.0	65.6	2 621
Egretta garzetta	0.000	0.000	753	0.069	0.025	6 585	0.016	0.014	2 060	0.733	0.733	152	0.0	61.8	4.5	33.8	7 153
Egretta alba	0.077	0.055	825	0.559	0.129	6 873	0.047	0.027	2 083	2.908	1.133	153	0.9	76.6	2.0	20.4	46 942
Ardea cinerea	0.166	0.118	863	0.594	0.122	7 067	0.091	0.030	2 176	2.180	0.600	161	1.9	79.3	3.8	14.9	48 210
Ardea purpurea	0.000	0.000	718	0.039	0.011	6 456	0.005	0.003	1 944	1.150	0.402	155	0.0	39.4	1.7	58.9	6 436
Bubulcus ibis	0.000	0.000	529	0.006	0.006	4 958	0.000	0.000	1 396	0.000	0.000	121	0.0	100.0	0.0	0.0	413
Ciconia nigra	0.000	0.000	883	0.128	0.091	7 019	0.021	0.015	2 174	0.000	0.000	157	0.0	95.0	5.0	0.0	8 700
Ciconia ciconia	0.771	0.283	894	0.886	0.079	7 124	0.116	0.048	2 230	1.096	0.503	162	6.4	84.7	3.5	5.4	67 355
Platalea leucorodia	0.000	0.000	831	0.069	0.036	6 870	0.000	0.000	2 124	1.976	1.246	153	0.0	40.5	0.0	59.5	10 937
Cygnus olor	0.447	0.328	783	0.018	0.014	6 753	0.018	0.015	2 096	1.984	1.449	157	23.7	11.0	3.4	61.9	10 560
Anser anser	0.044	0.044	729	0.398	0.166	6 424	0.017	0.017	1 871	13.465	4.898	150	0.3	36.3	0.5	62.9	70 546
Anas penelope	0.000	0.000	404	0.029	0.021	4 373	0.000	0.000	1 203	1.079	1.079	118	0.0	34.5	0.0	65.5	5 430
Anas strepera	0.000	0.000	477	0.007	0.005	4 252	0.000	0.000	1 185	0.516	0.516	111	0.0	19.9	0.0	80.1	2 122
Anas crecca	0.000	0.000	584	0.002	0.002	5 263	0.000	0.000	1 434	0.421	0.273	131	0.0	6.6	0.0	93.4	1 485
Anas platyrhynchos	1.761	0.868	885	2.232	0.222	7 054	1.121	0.250	2 197	33.616	6.687	159	3.4	50.1	7.9	38.6	287 080
Anas acuta	0.000	0.000	474	0.000	0.000	4 866	0.000	0.000	1 320	0.053	0.053	120	0.0	0.0	0.0	100.0	175
Anas querquedula	0.000	0.000	548	0.182	0.053	5 237	0.000	0.000	1 489	4.830	1.657	134	0.0	42.4	0.0	57.6	27 623
Anas clypeata	0.000	0.000	654	0.008	0.005	6 061	0.000	0.000	1 792	0.218	0.157	146	0.0	42.3	0.0	57.7	1 245
Aythya ferina	0.924	0.924	620	0.094	0.046	5 912	0.021	0.019	1 732	5.435	2.218	133	17.5	20.5	1.5	60.6	29 562
Aythya nyroca	0.312	0.312	715	0.051	0.027	6 218	0.006	0.006	1 791	3.667	1.453	138	10.1	19.0	0.7	70.2	17 210

Species	Relative density (individual/km²)													Habitat occupancy (%)			Estimated
	Urban	SE	n	Farmland	SE	n	Forest	SE	n	Wetlands	SE	n	Urban	Farmland	Forest	Wetlands	# of ind.
Aythya fuligula	0.000	0.000	609	0.000	0.000	5 304	0.000	0.000	1 470	0.343	0.263	130	0.0	0.0	0.0	100.0	1 129
Bucephala clangula	0.000	0.000	525	0.000	0.000	4 954	0.027	0.027	1 410	0.000	0.000	137	0.0	0.0	100.0	0.0	551
Mergus albellus	0.076	0.076	421	0.000	0.000	4 197	0.000	0.000	1 114	0.000	0.000	112	100.0	0.0	0.0	0.0	423
Mergus merganser	0.000	0.000	450	0.000	0.000	4 386	0.003	0.003	1 106	0.026	0.026	111	0.0	0.0	38.3	61.7	139
Pernis apivorus	0.000	0.000	433	0.010	0.007	4 608	0.011	0.009	1 407	0.000	0.000	118	0.0	72.7	27.3	0.0	843
Milvus migrans	0.000	0.000	627	0.004	0.003	5 798	0.000	0.000	1 781	0.079	0.079	135	0.0	49.6	0.0	50.4	514
Milvus milvus	0.000	0.000	563	0.003	0.002	5 438	0.000	0.000	1 598	0.000	0.000	132	0.0	100.0	0.0	0.0	179
Haliaeetus albicilla	0.000	0.000	708	0.013	0.005	6 202	0.013	0.010	1 803	0.000	0.000	147	0.0	75.0	25.0	0.0	1 078
Circus aeruginosus	0.240	0.124	791	0.908	0.067	6 592	0.067	0.027	2 013	4.238	1.061	154	1.8	77.8	1.8	18.6	75 139
Circus cyaneus	0.066	0.066	481	0.011	0.007	5 006	0.000	0.000	1 419	0.032	0.032	123	30.9	60.2	0.0	8.9	1 199
Circus pygargus	0.000	0.000	489	0.037	0.013	5 184	0.000	0.000	1 387	0.259	–	123	0.0	73.8	0.0	26.2	3 258
Accipiter gentilis	0.041	0.041	771	0.023	0.008	6 601	0.139	0.049	2 020	0.000	0.000	151	5.1	32.6	62.3	0.0	4 535
Accipiter nisus	0.139	0.066	753	0.070	0.017	6 490	0.195	0.059	2 053	0.054	0.040	151	8.3	47.6	42.2	1.9	9 410
Buteo buteo	0.411	0.120	855	1.806	0.084	7 035	2.071	0.157	2 208	2.153	0.725	158	1.4	69.3	25.1	4.2	167 818
Aquila heliaca	0.000	0.000	604	0.007	0.006	5 560	0.000	0.000	1 510	0.000	0.000	135	0.0	100.0	0.0	0.0	442
Falco tinnunculus	0.423	0.170	782	0.667	0.053	6 755	0.070	0.025	2 114	0.105	0.066	158	5.0	91.2	3.0	0.7	47 074
Falco vespertinus	0.047	0.047	680	0.170	0.047	6 424	0.000	0.000	1 957	0.000	0.000	151	2.3	97.7	0.0	0.0	11 178
Falco subbuteo	0.742	0.301	615	0.161	0.051	5 819	0.027	0.020	1 685	0.000	0.000	136	27.5	68.9	3.6	0.0	15 081
Falco cherrug	0.000	0.000	646	0.013	0.008	5 756	0.002	0.002	1 771	0.000	0.000	138	0.0	96.2	3.8	0.0	864
Falco peregrinus	0.000	0.000	588	0.001	0.001	5 434	0.010	0.010	1 684	0.000	0.000	137	0.0	16.7	83.3	0.0	252
Perdix perdix	0.045	0.039	818	0.426	0.090	6 818	0.047	0.027	2 043	0.000	0.000	151	0.9	95.8	3.3	0.0	28 628
Coturnix coturnix	0.136	0.064	796	3.284	0.130	6 883	0.161	0.035	2 087	0.242	0.135	152	0.4	97.8	1.5	0.4	216 279
Phasianus colchicus	2.406	0.329	898	11.450	0.258	7 149	5.146	0.289	2 234	6.907	1.236	159	1.5	84.0	11.9	2.6	878 131
Rallus aquaticus	0.000	0.000	579	0.058	0.017	5 190	0.005	0.005	1 503	1.544	0.531	132	0.0	41.7	1.2	57.1	8 907
Porzana porzana	0.000	0.000	334	0.008	0.006	3 417	0.000	0.000	847	0.000	0.000	103	0.0	100.0	0.0	0.0	500
Porzana parva	0.000	0.000	352	0.006	0.006	3 451	0.009	0.009	862	1.213	0.826	105	0.0	8.6	4.1	87.3	4 579
Crex crex	0.000	0.000	611	0.048	0.012	5 822	0.003	0.003	1 716	0.267	0.244	131	0.0	76.7	1.3	22.0	4 009
Gallinula chloropus	0.058	0.046	734	0.119	0.026	6 250	0.095	0.056	1 847	1.029	0.393	149	2.4	57.7	14.5	25.4	13 328

	Relative density (individual/km²)													Habitat occupancy (%)			Estimated
Species	Urban	SE	n	Farmland	SE	n	Forest	SE	n	Wetlands	SE	n	Urban	Farmland	Forest	Wetlands	# of ind.
Fulica atra	1.937	1.929	825	0.541	0.109	6 931	0.080	0.039	2 068	15.358	5.209	157	11.1	35.6	1.7	51.7	97 922
Grus grus	0.000	0.000	824	0.196	0.107	6 805	0.000	0.000	2 101	0.000	0.000	150	0.0	100.0	0.0	0.0	12 610
Otis tarda	0.000	0.000	834	0.018	0.009	6 907	0.000	0.000	2 091	0.000	0.000	154	0.0	100.0	0.0	0.0	1 138
Himantopus himantopus	0.095	0.095	669	0.058	0.023	6 108	0.000	0.000	1 820	0.293	0.231	141	10.1	71.4	0.0	18.4	5 250
Recurvirostra avosetta	0.041	0.041	768	0.022	0.008	6 637	0.000	0.000	1 960	1.466	1.125	152	3.6	21.8	0.0	74.6	6 473
Glareola pratincola	0.000	0.000	489	0.030	0.022	4 659	0.000	0.000	1 278	0.000	0.000	121	0.0	100.0	0.0	0.0	1 931
Charadrius dubius	0.000	0.000	484	0.034	0.013	4 583	0.016	0.014	1 193	0.838	0.573	122	0.0	41.6	6.3	52.1	5 295
Vanellus vanellus	0.595	0.252	820	5.303	0.290	7 031	0.217	0.180	2 137	3.818	1.275	157	0.9	94.4	1.2	3.5	361 796
Calidris minuta	0.000	0.000	231	0.121	0.092	2 640	0.000	0.000	651	0.000	0.000	96	0.0	100.0	0.0	0.0	7 764
Philomachus pugnax	0.000	0.000	503	1.696	0.861	5 286	0.000	0.000	1 443	0.000	0.000	129	0.0	100.0	0.0	0.0	109 187
Gallinago gallinago	0.000	0.000	481	0.210	0.066	5 282	0.000	0.000	1 643	0.277	0.241	134	0.0	93.7	0.0	6.3	14 429
Scolopax rusticola	0.000	0.000	529	0.000	0.000	5 684	0.009	0.009	1 827	0.000	0.000	133	0.0	14.5	85.5	0.0	207
Limosa limosa	0.492	0.492	518	0.192	0.089	5 153	0.000	0.000	1 291	0.296	0.296	129	17.1	76.8	0.0	6.1	16 094
Numenius phaeopus	0.000	0.000	406	0.209	0.166	3 648	0.000	0.000	984	0.000	0.000	115	0.0	100.0	0.0	0.0	13 484
Numenius arquata	0.000	0.000	549	0.033	0.014	4 923	0.000	0.000	1 324	0.059	0.059	124	0.0	91.5	0.0	8.5	2 307
Tringa erythropus	0.000	0.000	274	0.003	0.003	3 215	0.000	0.000	803	12.411	9.890	99	0.0	0.5	0.0	99.5	41 100
Tringa totanus	0.000	0.000	563	0.554	0.103	5 597	0.002	0.002	1 486	0.820	0.376	137	0.0	92.9	0.1	7.0	38 419
Tringa nebularia	0.000	0.000	297	0.009	0.005	3 091	0.000	0.000	796	0.000	0.000	98	0.0	100.0	0.0	0.0	578
Tringa ochropus	0.000	0.000	319	0.066	0.060	3 456	0.000	0.000	1 116	0.174	0.174	110	0.0	88.1	0.0	11.9	4 822
Tringa glareola	0.090	0.090	352	0.521	0.170	3 438	0.000	0.000	923	0.112	0.087	110	1.5	97.5	0.0	1.1	34 390
Actitis hypoleucos	0.000	0.000	430	0.161	0.094	4 476	0.000	0.000	1 372	0.403	0.231	114	0.0	88.6	0.0	11.4	11 685
Larus minutus	0.000	0.000	277	0.013	0.013	2 512	0.000	0.000	598	1.049	1.049	91	0.0	19.1	0.0	80.9	4 273
Larus ridibundus	0.439	0.201	821	0.969	0.362	6 799	0.652	0.375	2 027	21.274	7.978	161	1.7	42.1	8.9	47.3	148 163
Larus argentatus	0.000	0.000	462	0.002	0.002	4 271	0.000	0.000	1 189	0.000	0.000	123	0.0	100.0	0.0	0.0	148
Larus cachinnans	0.000	0.000	346	0.030	0.022	3 379	0.000	0.000	937	0.035	0.035	101	0.0	94.4	0.0	5.6	2 056
Sterna hirundo	0.000	0.000	540	0.007	0.003	5 149	0.000	0.000	1 431	0.121	0.098	135	0.0	52.7	0.0	47.3	839
Chlidonias hybridus	0.640	0.640	398	0.209	0.101	4 190	0.000	0.000	1 144	2.486	1.332	121	14.2	53.3	0.0	32.5	25 214
Chlidonias niger	0.000	0.000	463	0.251	0.169	4 805	0.000	0.000	1 212	0.562	0.396	119	0.0	89.7	0.0	10.3	18 029

Species	Relative density (individual/km²)													Habitat occupancy (%)			Estimated
	Urban	SE	n	Farmland	SE	n	Forest	SE	n	Wetlands	SE	n	Urban	Farmland	Forest	Wetlands	# of ind.
Chlidonias leucopterus	0.000	0.000	345	0.121	0.064	3 730	0.000	0.000	952	0.000	0.000	106	0.0	100.0	0.0	0.0	7 820
Columba livia f. domestica	30.114	4.698	646	3.347	0.781	4 903	0.037	0.025	1 416	0.063	0.063	113	43.8	56.0	0.2	0.1	384 978
Columba oenas	0.000	0.000	590	0.091	0.030	5 753	1.678	0.193	1 846	0.021	0.021	135	0.0	14.6	85.2	0.2	40 044
Columba palumbus	5.249	0.671	832	3.021	0.195	6 833	4.685	0.245	2 123	2.740	0.690	156	8.9	59.3	29.0	2.8	328 216
Streptopelia decaoto	37.699	1.610	898	4.635	0.218	7 136	2.079	0.196	2 220	1.893	0.607	163	37.8	53.5	7.6	1.1	557 832
Streptopelia turtur	3.382	1.270	838	4.119	0.222	6 925	8.717	0.344	2 185	2.306	0.602	157	4.0	56.6	37.8	1.6	469 038
Cuculus canorus	1.783	0.284	889	3.223	0.119	7 100	7.347	0.265	2 234	7.210	1.137	159	2.6	53.1	38.2	6.1	390 659
Athene noctua	0.189	0.137	739	0.018	0.008	6 690	0.016	0.016	1 985	0.000	0.000	149	41.6	45.5	12.9	0.0	2 534
Strix aluco	0.007	0.007	653	0.014	0.010	6 236	0.047	0.021	1 960	0.000	0.000	142	2.1	47.5	50.5	0.0	1 881
Asio otus	0.000	0.000	815	0.079	0.025	6 755	0.046	0.024	2 058	0.140	0.110	152	0.0	78.7	14.2	7.1	6 500
Asio flammeus	0.000	0.000	576	0.007	0.005	5 313	0.000	0.000	1 448	0.000	0.000	134	0.0	100.0	0.0	0.0	463
Caprimulgus europaeus	0.000	0.000	689	0.001	0.001	6 055	0.000	0.000	1 861	0.000	0.000	141	0.0	100.0	0.0	0.0	86
Apus apus	3.260	1.899	846	0.188	0.067	6 652	0.035	0.027	2 042	0.000	0.000	156	58.7	39.0	2.3	0.0	31 061
Alcedo atthis	0.000	0.000	857	0.014	0.007	6 959	0.021	0.016	2 130	0.603	0.300	163	0.0	27.3	13.0	59.7	3 325
Merops apiaster	0.527	0.408	855	1.443	0.212	7 074	0.519	0.136	2 195	0.078	0.062	163	2.8	87.1	9.9	0.2	106 693
Coracias garrulus	0.000	0.000	765	0.129	0.027	6 632	0.124	0.073	2 094	0.000	0.000	156	0.0	76.7	23.3	0.0	10 852
Upupa epops	0.307	0.091	873	0.696	0.058	7 034	0.656	0.078	2 210	0.312	0.212	158	2.8	73.6	21.9	1.7	60 909
Jynx torquilla	0.210	0.057	726	0.581	0.050	6 318	1.269	0.136	1 996	0.403	0.242	143	1.8	56.9	39.3	2.0	65 707
Picus canus	0.055	0.055	580	0.002	0.001	5 139	0.249	0.063	1 618	0.000	0.000	132	5.6	2.4	92.0	0.0	5 496
Picus viridis	0.646	0.194	871	0.259	0.031	6 828	1.234	0.121	2 182	0.193	0.097	157	7.9	36.2	54.6	1.4	45 999
Dryocopos martius	0.056	0.028	853	0.068	0.013	6 948	1.859	0.138	2 190	0.423	0.247	159	0.7	9.9	86.2	3.2	43 861
Dendrocopos major	2.318	0.287	859	1.041	0.066	6 792	10.321	0.324	2 203	1.848	0.605	157	4.4	22.6	70.9	2.1	295 958
Dendrocopos syriacus	0.912	0.169	755	0.192	0.030	6 332	0.600	0.101	1 875	0.000	0.000	156	17.2	41.7	41.1	0.0	29 691
Dendrocopos medius	0.442	0.121	723	0.134	0.025	6 332	1.674	0.172	1 981	0.083	0.066	145	5.4	19.0	75.0	0.6	45 419
Dendrocopos leucotos	0.000	0.000	561	0.000	0.000	5 284	0.107	0.059	1 536	0.000	0.000	120	0.0	0.0	100.0	0.0	2 168
Dendrocopos minor	0.205	0.071	810	0.102	0.020	6 512	0.923	0.115	2 081	0.096	0.069	143	4.3	24.5	70.0	1.2	26 793
Calandrella brachydactyla	0.000	0.000	286	0.022	0.014	3 232	0.000	0.000	684	0.000	0.000	99	0.0	100.0	0.0	0.0	1 411
Galerida cristata	1.966	0.351	877	3.585	0.175	6 964	0.125	0.043	2 159	1.006	0.504	154	4.4	93.2	1.0	1.3	247 728

Species	Relative density (individual/km²)													Habitat occupancy (%)			Estimated
	Urban	SE	n	Farmland	SE	n	Forest	SE	n	Wetlands	SE	n	Urban	Farmland	Forest	Wetlands	# of ind.
Lullula arborea	0.131	0.076	512	0.188	0.035	4 835	1.332	0.167	1 558	0.046	0.046	116	1.8	30.2	67.6	0.4	40 045
Alauda arvensis	2.583	0.444	873	43.425	0.963	7 047	2.785	0.285	2 202	20.726	9.558	157	0.5	95.3	1.9	2.3	2 935 468
Riparia riparia	0.560	0.319	815	2.468	1.037	6 806	0.603	0.256	2 033	8.335	6.193	159	1.6	78.8	6.1	13.6	201 761
Hirundo rustica	24.609	2.214	894	8.573	0.476	7 090	1.618	0.284	2 213	6.028	2.585	163	18.5	74.4	4.4	2.7	742 444
Delichon urbica	19.166	3.265	882	3.025	0.320	7 048	0.611	0.182	2 186	3.519	2.623	158	32.9	59.7	3.8	3.6	326 019
Anthus campestris	0.082	0.082	388	0.436	0.063	3 679	0.003	0.003	1 006	0.000	0.000	105	1.6	98.2	0.2	0.0	28 615
Anthus trivialis	0.782	0.306	509	0.867	0.084	4 656	3.776	0.289	1 514	0.705	0.350	117	3.1	40.1	55.1	1.7	139 339
Anthus pratensis	0.000	0.000	387	0.274	0.058	3 440	0.031	0.031	1 040	0.000	0.000	110	0.0	96.6	3.4	0.0	18 243
Anthus cervinus	0.000	0.000	268	0.012	0.009	2 557	0.000	0.000	587	0.000	0.000	87	0.0	100.0	0.0	0.0	802
Motacilla flava	0.703	0.233	773	11.865	0.331	6 651	0.382	0.173	1 984	8.570	1.690	153	0.5	95.0	1.0	3.5	803 905
Motacilla citreola	0.163	0.163	390	0.000	0.000	3 661	0.000	0.000	985	0.000	0.000	116	100.0	0.0	0.0	0.0	913
Motacilla cinerea	0.000	0.000	554	0.039	0.019	5 201	0.218	0.063	1 649	0.021	0.021	137	0.0	35.6	63.4	1.0	6 978
Motacilla alba	2.859	0.368	895	2.398	0.135	7 088	1.133	0.332	2 211	3.123	0.747	158	7.9	75.8	11.3	5.0	203 735
Bombycilla garrulus	0.000	0.000	768	0.000	0.000	6 556	0.059	0.036	2 069	0.000	0.000	149	0.0	0.0	100.0	0.0	1 199
Troglodytes troglodytes	0.132	0.066	848	0.156	0.023	6 861	2.576	0.199	2 142	0.339	0.147	151	1.2	15.6	81.5	1.7	64 295
Prunella modularis	0.006	0.006	528	0.023	0.014	5 029	0.158	0.043	1 511	0.000	0.000	121	0.7	31.5	67.8	0.0	4 740
Erithacus rubecula	0.814	0.186	884	0.661	0.053	6 982	14.978	0.438	2 207	1.142	0.371	158	1.3	12.0	85.7	1.1	355 455
Luscinia luscinia	0.077	0.061	553	0.013	0.008	4 870	0.042	0.019	1 394	0.000	0.000	108	20.3	39.5	40.2	0.0	2 117
Luscinia megarhynchos	3.873	0.389	860	5.963	0.187	6 977	9.196	0.415	2 176	6.800	1.112	160	3.5	62.4	30.4	3.6	615 046
Luscinia svecica	0.000	0.000	706	0.067	0.017	6 200	0.000	0.000	1 896	1.790	0.568	144	0.0	42.2	0.0	57.8	10 200
Phoenicurus ochruros	16.153	0.807	884	1.430	0.097	7 028	0.474	0.116	2 163	0.541	0.300	157	46.6	47.5	5.0	0.9	193 850
Phoenicurus phoenicurus	0.400	0.181	800	0.109	0.025	6 891	0.049	0.024	2 077	0.015	0.015	149	21.7	68.2	9.6	0.5	10 329
Saxicola rubetra	0.534	0.208	587	2.129	0.148	5 768	0.200	0.064	1 761	2.027	0.627	142	2.0	90.9	2.7	4.4	150 841
Saxicola torquata	1.764	0.325	773	5.637	0.177	6 673	1.319	0.165	2 027	5.559	0.988	153	2.4	86.8	6.4	4.4	417 951
Oenanthe oenanthe	0.787	0.291	633	0.592	0.060	5 596	0.092	0.039	1 673	0.243	0.188	135	9.7	84.3	4.2	1.8	45 224
Turdus merula	44.112	2.297	901	7.492	0.238	7 169	27.577	0.578	2 253	5.432	1.332	163	18.9	36.9	42.9	1.4	1 307 953
Turdus pilaris	0.210	0.135	757	0.039	0.018	6 550	0.118	0.040	2 066	0.000	0.000	151	19.3	41.1	39.6	0.0	6 087
Turdus philomelos	3.366	0.419	780	1.507	0.083	6 628	12.416	0.373	2 150	0.980	0.359	154	5.1	26.1	67.9	0.9	371 635

	Relative density (individual/km²)													Habitat occupancy (%)			Estimated
Species	Urban	SE	n	Farmland	SE	n	Forest	SE	n	Wetlands	SE	n	Urban	Farmland	Forest	Wetlands	# of ind.
Turdus iliacus	0.000	0.000	573	0.003	0.003	5 365	0.006	0.006	1 651	0.000	0.000	124	0.0	59.4	40.6	0.0	322
Turdus viscivorus	0.028	0.021	601	0.034	0.011	5 366	0.524	0.084	1 794	0.000	0.000	134	1.2	16.9	81.9	0.0	13 016
Locustella naevia	0.111	0.071	506	0.501	0.054	4 912	0.214	0.052	1 488	0.182	0.114	128	1.6	85.3	11.5	1.6	37 870
Locustella fluviatilis	0.158	0.121	542	0.654	0.067	5 125	1.556	0.184	1 521	2.342	0.739	138	1.1	51.1	38.4	9.4	82 349
Locustella luscinioides	0.051	0.037	518	0.653	0.064	5 503	0.251	0.076	1 525	13.162	1.531	137	0.3	46.3	5.6	47.8	90 799
Acrocephalus melanopogon	0.000	0.000	378	0.043	0.017	3 904	0.000	0.000	1 129	0.259	0.182	123	0.0	76.4	0.0	23.6	3 606
Acrocephalus paludicola	0.000	0.000	428	0.016	0.010	4 380	0.027	0.027	1 162	0.000	0.000	121	0.0	64.3	35.7	0.0	1 560
Acrocephalus schoenobaenus	0.294	0.211	480	3.475	0.200	4 941	0.295	0.097	1 274	23.729	2.907	130	0.5	72.3	1.9	25.3	309 565
Acrocephalus palustris	0.232	0.113	494	0.946	0.094	4 859	0.181	0.067	1 362	3.656	0.982	136	1.7	78.2	4.7	15.5	77 949
Acrocephalus scirpaceus	0.087	0.061	548	1.000	0.092	5 434	0.122	0.054	1 446	17.310	2.244	142	0.4	51.8	2.0	45.9	124 364
Acrocephalus arundinaceus	1.176	0.337	744	2.738	0.152	6 653	0.668	0.122	1 946	16.728	2.333	149	2.6	70.1	5.4	21.9	251 544
Hippolais pallida	0.000	0.000	201	0.026	0.026	2 449	0.000	0.000	609	0.000	0.000	67	0.0	100.0	0.0	0.0	1 674
Hippolais icterina	0.263	0.170	423	0.075	0.017	4 038	0.154	0.052	1 229	0.884	0.506	108	11.9	39.0	25.4	23.6	12 334
Sylvia nisoria	0.138	0.116	557	0.607	0.061	5 455	0.495	0.112	1 675	0.157	0.110	136	1.5	77.5	20.0	1.0	50 473
Sylvia curruca	1.456	0.270	485	0.966	0.074	4 542	1.391	0.160	1 412	1.024	0.402	107	8.0	61.0	27.7	3.3	102 026
Sylvia communis	0.925	0.195	647	2.806	0.129	5 649	1.438	0.157	1 651	1.749	0.539	135	2.3	81.8	13.2	2.6	220 852
Sylvia borin	0.389	0.132	470	0.129	0.025	4 835	0.344	0.084	1 412	0.100	0.100	127	12.2	46.6	39.4	1.9	17 795
Sylvia atricapilla	7.051	0.563	838	5.154	0.167	6 639	26.603	0.593	2 104	5.378	1.071	151	4.2	35.7	58.2	1.9	930 045
Phylloscopus sibilatrix	0.378	0.141	524	0.283	0.049	4 694	5.317	0.348	1 562	0.303	0.268	120	1.6	14.1	83.5	0.8	129 463
Phylloscopus collybita	1.725	0.255	813	1.640	0.093	6 379	22.226	0.528	2 073	2.735	0.892	143	1.7	18.3	78.4	1.6	576 243
Phylloscopus trochilus	0.217	0.097	590	0.388	0.053	4 899	2.190	0.205	1 524	0.568	0.549	116	1.7	34.4	61.3	2.6	72 636
Regulus regulus	0.000	0.000	731	0.009	0.006	6 277	0.452	0.105	1 936	0.000	0.000	145	0.0	5.9	94.1	0.0	9 782
Regulus ignicapellus	0.000	0.000	710	0.008	0.006	6 140	0.076	0.039	1 877	0.000	0.000	147	0.0	25.6	74.4	0.0	2 072
Muscicapa striata	0.809	0.174	628	0.355	0.046	5 763	1.512	0.162	1 814	0.617	0.225	139	7.5	38.0	51.1	3.4	60 134
Ficedula parva	0.035	0.035	457	0.009	0.004	4 717	0.038	0.013	1 504	0.000	0.000	118	12.7	36.6	50.7	0.0	1 540
Ficedula albicollis	0.655	0.265	640	0.229	0.045	5 749	4.315	0.311	1 871	0.041	0.041	141	3.4	13.9	82.5	0.1	106 313
Ficedula hypoleuca	0.008	0.008	574	0.040	0.012	5 734	0.181	0.045	1 783	0.000	0.000	135	0.7	40.6	58.7	0.0	6 269
Panurus biarmicus	0.000	0.000	705	0.065	0.020	6 321	0.022	0.017	1 923	3.938	1.541	148	0.0	23.8	2.6	73.7	17 615

Species	Relative density (individual/km²)													Habitat occupancy (%)			Estimated
	Urban	SE	n	Farmland	SE	n	Forest	SE	n	Wetlands	SE	n	Urban	Farmland	Forest	Wetlands	# of ind.
Aegithalos caudatus	1.995	0.673	884	0.723	0.117	6 968	4.534	0.437	2 157	1.368	0.762	159	7.2	30.1	59.7	2.9	154 426
Parus palustris	1.534	0.553	819	0.248	0.033	6 709	3.681	0.250	2 122	2.596	2.112	152	7.9	14.8	69.3	7.9	107 988
Parus montanus	0.013	0.013	491	0.022	0.015	4 765	0.279	0.178	1 521	0.000	0.000	114	1.0	19.8	79.2	0.0	7 162
Parus cristatus	0.000	0.000	747	0.003	0.001	6 361	0.092	0.041	2 005	0.000	0.000	151	0.0	8.7	91.3	0.0	2 043
Parus ater	0.039	0.022	684	0.009	0.007	5 722	0.773	0.102	1 836	0.000	0.000	140	1.3	3.4	95.3	0.0	16 512
Parus caeruleus	2.224	0.489	886	0.715	0.066	7 080	8.347	0.412	2 219	1.846	0.588	159	5.3	19.6	72.4	2.6	234 323
Parus major	20.693	1.541	897	6.970	0.274	7 163	37.082	0.747	2 231	10.167	1.673	159	8.6	33.2	55.8	2.5	1 352 189
Sitta europaea	0.460	0.108	885	0.206	0.031	6 891	8.914	0.354	2 179	0.666	0.286	158	1.3	6.7	91.0	1.1	199 322
Certhia familiaris	0.000	0.000	449	0.016	0.010	3 859	0.490	0.110	1 262	0.000	0.000	102	0.0	9.5	90.5	0.0	11 017
Certhia brachydactyla	0.000	0.000	535	0.044	0.019	4 573	1.553	0.165	1 461	0.203	0.180	119	0.0	8.1	90.0	1.9	35 085
Remiz pendulinus	0.044	0.044	731	0.061	0.014	6 403	0.078	0.042	1 896	1.864	0.566	153	2.1	33.0	13.3	51.7	11 881
Oriolus oriolus	3.024	0.331	895	3.632	0.132	7 085	9.364	0.375	2 222	4.996	1.019	163	3.7	51.1	41.6	3.6	457 678
Lanius collurio	2.396	0.328	810	6.865	0.182	6 968	3.911	0.259	2 186	2.970	0.667	159	2.5	81.1	14.6	1.8	544 776
Lanius minor	0.272	0.199	662	0.735	0.059	6 082	0.151	0.045	1 836	0.531	0.291	140	2.8	88.2	5.7	3.3	53 646
Lanius exubitor	0.000	0.000	712	0.083	0.023	6 376	0.027	0.020	1 949	0.000	0.000	145	0.0	90.6	9.4	0.0	5 887
Garrulus glandarius	1.139	0.205	877	1.078	0.104	7 009	7.384	0.323	2 222	0.682	0.275	162	2.8	30.4	65.8	1.0	228 189
Pica pica	7.549	0.905	896	2.948	0.137	7 139	0.938	0.130	2 225	3.199	0.868	159	16.1	72.5	7.3	4.0	261 643
Corvus monedula	2.082	1.182	877	0.256	0.107	6 933	0.005	0.005	2 131	0.000	0.000	156	41.3	58.3	0.4	0.0	28 201
Corvus frugilegus	3.454	0.934	888	4.389	0.788	7 124	0.185	0.059	2 177	0.201	0.201	158	6.3	92.2	1.2	0.2	306 342
Corvus corone cornix	1.623	0.274	883	2.072	0.136	7 054	0.496	0.122	2 188	3.265	0.879	159	5.6	81.7	6.2	6.6	163 315
Corvus corax	0.084	0.047	850	0.386	0.133	7 044	0.609	0.111	2 191	0.075	0.075	155	1.2	65.4	32.7	0.6	37 943
Sturnus vulgaris	26.887	4.461	899	38.016	2.922	7 073	19.547	1.698	2 236	23.517	####	163	4.9	79.6	12.9	2.5	3 073 227
Passer domesticus	137.415	5.246	900	14.600	0.751	7 164	1.795	0.370	2 240	9.623	4.308	163	43.3	52.9	2.1	1.8	1 777 090
Passer montanus	36.899	2.900	882	32.973	1.088	7 084	5.028	0.541	2 210	21.496	5.122	156	8.2	84.8	4.1	2.8	2 502 622
Fringilla coelebs	7.347	0.648	846	4.899	0.185	6 935	40.280	0.766	2 230	6.219	1.390	161	3.4	26.4	68.5	1.7	1 196 194
Fringilla montifringilla	0.033	0.033	643	0.014	0.011	5 962	0.092	0.042	1 951	0.000	0.000	139	6.2	30.3	63.5	0.0	2 962
Serinus serinus	10.814	0.741	758	1.167	0.094	6 252	0.588	0.095	1 950	0.663	0.314	147	40.4	50.2	8.0	1.5	149 803
Carduelis chloris	18.837	0.925	894	4.812	0.196	6 996	4.879	0.336	2 219	3.883	0.936	158	20.0	58.8	18.8	2.4	527 232

Species	Relative density (individual/km²)													Habitat occupancy (%)			Estimated
	Urban	SE	n	Farmland	SE	n	Forest	SE	n	Wetlands	SE	n	Urban	Farmland	Forest	Wetlands	# of ind.
Carduelis carduelis	18.105	1.169	892	8.021	0.388	7 072	3.385	0.390	2 210	5.594	2.610	163	14.4	73.3	9.8	2.6	705 011
Carduelis spinus	0.350	0.124	715	0.063	0.022	6 194	0.174	0.056	1 909	0.038	0.038	141	20.3	41.7	36.7	1.3	9 650
Carduelis cannabina	2.049	0.417	707	1.174	0.104	6 064	0.337	0.099	1 846	0.351	0.183	138	12.1	79.5	7.2	1.2	95 048
Carduelis flammea	0.000	0.000	481	0.004	0.003	4 975	0.006	0.006	1 383	0.000	0.000	127	0.0	67.3	32.7	0.0	357
Loxia curvirostra	0.000	0.000	744	0.000	0.000	6 454	0.013	0.009	2 053	0.000	0.000	152	0.0	0.0	100.0	0.0	263
Pyrrhula pyrrhula	0.021	0.013	759	0.016	0.008	6 515	0.063	0.028	2 078	0.000	0.000	153	4.9	41.9	53.3	0.0	2 405
Coccothraustres coccothraustes	0.372	0.091	862	0.503	0.082	6 917	4.783	0.295	2 187	0.256	0.148	157	1.6	24.4	73.4	0.6	132 570
Emberiza citrinella	1.593	0.282	789	4.897	0.192	6 610	15.170	0.545	2 117	2.258	0.605	150	1.4	49.3	48.2	1.2	640 201
Emberiza cirlus	0.000	0.000	309	0.000	0.000	3 434	0.005	0.005	1 072	0.000	0.000	94	0.0	0.0	100.0	0.0	101
Emberiza cia	0.000	0.000	487	0.007	0.007	4 562	0.067	0.040	1 378	0.215	0.174	121	0.0	17.8	54.0	28.1	2 521
Emberiza hortulana	0.000	0.000	382	0.006	0.004	3 744	0.000	0.000	1 105	0.000	0.000	104	0.0	100.0	0.0	0.0	404
Emberiza schoeniclus	0.028	0.020	613	0.951	0.080	5 465	0.172	0.063	1 536	9.435	1.465	138	0.2	63.8	3.6	32.4	95 964
Miliaria calandra	1.569	0.333	698	8.555	0.240	6 152	1.073	0.135	1 925	3.056	0.986	143	1.5	93.1	3.7	1.7	591 537