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Evaluation following the grassland restoration of Egyek-Pusztakócs according to Skylark (*Alauda arvensis*)

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Abstract: Egyek-Pusztakócs is the location of the longest (since 1976) and largest (over 5000 ha) habitat restoration project in Hungary so far. In the second phase about 700 hectares arable land was restored to grassland between 2004-2008. We have conducted observations and point counts of Skylark (*Alauda arvensis*) to monitor the effects of grassland reconstruction on arable lands between 2004–2008. In the first year of grassland restoration the grassland reconstruction correlated with a decline in the abundance of Skylarks, likely due to high weed cover in the spring following grassland restoration. But since the second year of grassland restoration, the strenght has increased significantly. We experienced that the year 2008 differs significantly from all the other years. In conclusion, we found evidence for the grassland reconstruction leading to an increased Skylark’s population.

Keywords: Farmland Bird Index, grassland restoration, Hortobágy, Hungary, landscape-level rehablitiation

1. Introduction

The grasslands, engendered by the relatively small amount of precipitation and the extreme temperature fluctuation between summer and winter, spread principally on the northern and southern temperate zones. These territories have always been used by mankind for cultivation and stock-raising, among which some regions' animal husbandry dates back such a long time, that its effects on the territory are almost invisible [1]. In Europe, primarily the plain, flat territories were cultivated, which are principally to be found in Eastern- and Western Europe.

The first popular extensive cultivation method did not lead to the dramatical decrease of biodiversity, to the contrary: at some places it even assisted to its growth. The plants and arthropods, all at least in some way adapted to the changed conditions, reach a high number of species especially on the less fertile lands used for stock-raising [2, 3]. Because of the intensification of agriculture, which appeared in the 1600's and then gained speed in the 20th century, the species linked to the agrarian landscape had to endure a constantly growing degree of negative impact. Primarily because of the increased demand of food due to the ever growing human population, the majority of semi-natural grasslands is intensively used for cultivation (plains) or have quitted (hills and highlands) [4, 5]. As a result to all this, the majority of the habitats was transformed and the biodiversity has decreased dramatically [6, 7]. A significant part of the remaining grasslands (in industrialized countries) is under anthropogenic influence and has been degradated and fragmentated, until it only served as a habitat to broadly tolerant, widely spread species.

The environmental effects of extensive and intensive cultivation methods differ remarkably from each other. During the process of extensive land use, no or only a small amount of fertilizers and chemicals is used, and the use of fossil energy sources is limited [8, 9]. A significantly higher level of biodiversity characterises these habitats. Contrarily to this, the intensive land use includes the broad utilization of chemicals, the exaggerated fertilization of the soil and the modernization of agricultural methods.

In Western Europe, many studies have been made concerning the effect of extensive and intensive agriculture on birds. The strength of bird species linked to agrarian lanscapes has drastically decreased due to the agriculture becoming more intensive and profit-oriented. In Great-Britain, a strength-increase of 80% has been indicated at three species: the Tree Sparrow (*Passer montanus*), the Grey Partridge (*Perdix perdix*) and the Corn Bunting (*Emberzia calandra*) [10, 11]. On the whole, the division of the previously mosaic land structure and the impoverishment of the vegetation implied the impoverishment of bird species. [12]. The most striking in the agricultural areas is that songbirds that feed on seeds have been forced back, which may be due to the change in the cultivation of arable fields and, respectively, the disappearance of these areas. Conclusions of surveys agree that the extensive way of farming is much more favourable for the survival of natural wildlife, especially in those areas where the landscape has a typically mosaic-like structure. However, to understand the effects of the given management methods on bird populations, we need to recognize the key factors that influence the breeding, foraging and other habits of birds in the agricultural areas [13].

To monitor the changes taking place in the landscape and the given regions, indices and indicators of various quality and quantity are the most suitable. From among the three main groups of landscape indicators (ecological, socio-economic and landscape aesthetic), it is the ecological indices that react the quickest to the changes taking place in the landscape. Respecting the influencing factors at the landscape level, we have very little knowledge, in spite of that most of the farm management activities happen at this level. This includes birds, by the investigation of which the ecological state and functioning of a given habitat, as well as the changes at landscape level and the land use can be judged [14].

The Skylark (*Alauda arvensis*) for breeding primarily prefers sites covered well by vegetation in lowland areas. For that reason, in addition to the natural grassy steppes, agricultural areas also provide favourable breeding conditions for the species. In Hungary, the largest populations of the species live in the Central Region (Kiskunság) and the eastern part of the Great Plain (Hortobágy, Tiszántúl) [15]. If we examine its distribution and population density, we find similarity with the extension of grasslands to a great extent [14]. Since the 1970's a decrease in its population has been experienced throughout Europe [16, 17]. There are three reasons for that: the use of biocides [18], the substitution of spring by winter cereal [19], and the reduction of long-term fallow [20]. Several studies showed that on adjacent, extensively and intensively managed areas, the population density of the Skylark shifts towards the extensive area to a larger or smaller extent [21, 22].

The biggest grassy regions in Hungary can be found in the Central Region (Kiskunság) and the eastern part of the Great Plain (Hortobágy, Tiszántúl). The majority of the originally vast grasslands have been altered [23], therefore it became necessary to reconstruct the still remaining natural-like habitats as soon as possible [24]. The oldest habitat reconstruction and rehabilitation project in Hungary at the landscape level (ongoing since 1976), covering at the same time the biggest area (more than 5000 ha) takes place in the Egyek-Pusztakócs marshland area in the Hortobágy. The hydrological rehabilitation of the marshland system began in 1976. Its first phase was completed by 1982 in Fekete-rét. In 1996-97 the flooding canal system, joining the Bőgő-lapos, the Kis-Jusztus marsh, the Meggyes- and Hagymás-lapos and finally the Csattag-marsh, reached completion [25]. The most important element of the second phase of the long-term landscape rehabilitation programme is the grassland reconstruction started in 2004, in course of which loess steppes and salt steppes are to be developed in some 700 ha arable field. In order to monitor the success of the grassland reconstruction, there have been first of all botanical surveys carried out [26, 27, 28], while zoological ones were much less [29, 30, 31].

In the case of all nature conservation management and restoration, it is an inevitable condition to precisely know the reactions of the given bird species, the changes in their population size, as these experiences are extremely important for the further landscape rehabilitation activities ("conservation based on evidences") [32]. The objective of the present study is to evaluate the grassland restoration through the monitoring of the Skylark population, with special respect to the first year following the grassland restoration and, respectively, the years after well established grasslands have developed.

We are looking for answers to the following questions: Will the size of the Skylark population that decreased due to tall vegetation developed in the first year following the grassland restoration increase again after well established grasslands have developed? If yes, in which year will it start and in what extent will it grow?

2. Materials and Methods

The habitat complex of Egyek-Pusztakócs extending to 4000 ha is situated along the western edge of the Hortobágy National Park. Its development has been defined mainly by the Tisza: the floods of the river established point bars, loess ridges and lowly lying beds. Apart from the "classical" flat Hortobágy, significant differences in the relief level have developed here. Partly as a result of this, a landscape of extremely mosaic-like structure has evolved including grassy areas (salt steppes and loess steppe grasslands), marshes, which are drying out or have continuous water cover, arable fields, burial mounds and woody habitats. All this is favourable for the biodiversity of the flora and the fauna.

In the examined sample area first of all alfalfa (*Medicago sativa*), spring and winter wheat (*Triticum aestivum*) and sunflower (*Helianthus annuus*) was grown. In the autumn season of 2005 and 2006, in half-and-half, following an appropriate soil preparation in the arable fields, a restoration of loess steppe and salt steppe grasslands took place by sowing two types of grass seed mixture. In the first year, more than half meter tall, weedy vegetation developed. Beginning from the second year, however, the sown grass species became dominant, while in the third year a state characteristic to primary grasslands has developed. The survey of the bird population was carried out in altogether 22 sampling points between April 1st and May 30th in each year, at one occasion. Sampling was carried out most frequently by the well known Danish system of point counts. In the course of this, we marked counting points on the map, in a way that the circular observation zones of 100 m radius of each counting point covered more or less the entire examined arable filed (under 10 ha), or were located systematically at 250 to 300 m distances from each other (in the case of fields larger than 10 ha). Where we had an option, we chose high ground points, from where the observation zone was better seen. At the counting points, in a circle of 100 m radius, counting was made through a five minute period of time. In those points where the circle of 100 m radius could not be set up due to the form of the area, we made counting by the observation of an area the size of which was similar to the circle of 100 m radius (approximately 3 ha), starting the counting from the edges of the field, lasting also for a five minutes period. This method became especially important in the rainy year of 2006, when several former counting points were under water due to the extending inland water. We involve in this study only those 12 arable fields, in the case of which the ornithological survey was carried out in each year of the period between 2004 and 2008.

During the data evaluation the emphasis was given to the monitoring of changes in the size of farmland bird populations. In the United Kingdom the Farmland Bird Index (FBI) was developed to monitor together the population size of 19 bird species breeding primarily in agricultural areas. This index has been recognized by the Central Statistical Office of Great Britain, as well as its modified version by the EUROSTAT, the statistical office of the EU, as official indicator for biodiversity [33]. One of these species is the Skylark (*Alauda arvensis*). In the present study we investigate its population size changes following a grassland restoration.

For the data analysis of Skylark population Wilcoxon matched-pairs signed-ranks test were used, using Graphpad Instat software.

3. Results and discussions

The most typical four breeding species of the examined area were the Grey-lag Goose (*Anser anser*), the Skylark (*Alauda arvensis*), the Yellow Wagtail (*Motacilla flava*) and the Lapwing (*Vanellus vanellus*). From among these, we have chosen the Skylark, typical both in grasslands and arable fields, to use for the investigation of grassland restoration activities. The present study analyses those 12 arable fields, in the case of which the sampling was carried out in each year of the five-year period of time. From among them there were six fields restored to grasslands in 2005 and another six in 2006. During the spring and early summer following the grassland restoration, weed species dominated the former arable fields. However, after the mowing of the weeds at the end of June, strong and locally closed stands of the sown grass species could be observed.

First we evaluated the period of time between 2004 and 2006; that is we looked for an answer to the following question: How does the vegetation developed in the first year following the grassland restoration (2006) effect the size of the Skylark population?

The Skylark prefers those dryer patches of the habitat having shorter vegetation, from where it is able to look out, and, respectively, where it finds food as it feeds on seeds. Our results comply with this, as we found that the abundance of the

Skylark fall in the fields which were restored to grasslands in the autumn of 2005, and covered by weeds in the spring of 2006 (Figure 1.a), while the abundance of the species – except one case - increased in the control fields that were not restored to grasslands, but have been further cultivated as arable land (Figure 1.b). The only exception was an arable field surrounded by such other arable lands where the grassland restoration began everywhere in 2005. The reason for the growth in abundance in the control fields may be that a part of the Skylark population drew to the control fields as a significant part of the arable land became unsuitable for nesting due to the extensive water cover or the springtime weed cover of restored grasslands (local effect). It is also possible, that due to the several smaller, temporary inland waters evolved in the neighbouring areas of the Hortobágy in 2006, the population became more abundant in the suitable, dry habitat patches (regional effect). Should the reason be anything, our results support by all means that the transitional conditions between the arable land and the future salt steppe grasslands are not favourable for the Skylark.

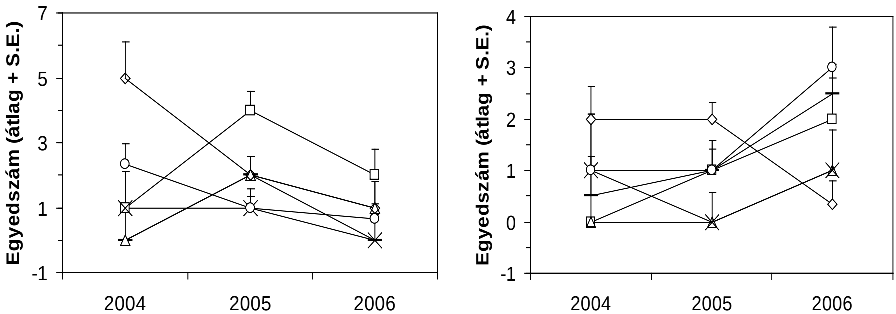

Figure 1: Changes in the abundance of Skylark *(Alauda arvensis)* in the areas of grassland reconstruction (a) and on non-restored arable lands (b). The Y axis shows the number of individuals counted during 5 min in a 100-m-radius circle (ca. 3 ha) around counting points.

Arable fields sown in 2005 and 2006 alike have established a state typical to the primary grasslands by the year 2008: the sown characteristic species (*Festuca pseudovina, F. rupicola*) have developed closed stands, and various dicotyledonous species [e.g. Tuberous Jerusalem Sage (*Phlomis tuberosa)*, Meadow Sage (*Salvia pratensis*)] appeared among them. Therefore, in the second analysis, we compared the year 2008 with all the other years. The following numbers of skylark territories could be observed in each of the respective years (Table 1, Figure 2).

Table 1: Skylark's *(Alauda arvensis)* territories between 2004-2008 in Egyek-Pusztakócs

Year	Number of territories
2004	31
2005	26
2006	32
2007	18
2008	65

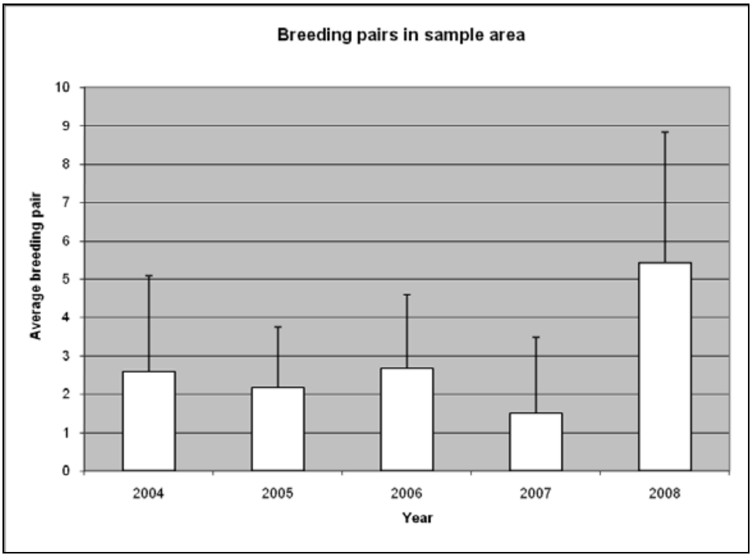

Figure 2: Changes in the territories of Skylark (*Alauda arvensis*) in the areas of grassland reconstruction

Annual mean value of nesting pairs was compared using the Wilcoxon test as the standard Gaussian distribution required by the parametric tests was not met in each of the cases. The findings demonstrate that mean values for nesting pairs in 2008 differed significantly from those in any of the previous years. (Table 2).

Table 2: Relevance of breeding Skylark pairs (mean) between 2004-2008 in Egyek-Pusztakócs (p = probability value, sig = significance level, * = 0,01-0,05, ** = 0,01-0,001, *** = 0,001>)

Wilcoxon matched-pairs signed-ranks test		
	p	**sig**
2004 vs 2008	0,0068	**
2005 vs 2008	0,0098	**
2006 vs 2008	0,0137	*
2007 vs 2008	0,002	**

Based on all the above, we experienced that the year 2008 differs significantly from all the other years. It is supported by the change in the number of home ranges in the investigated 12 arable fields between 2004 and 2008. The habitat preference of the Skylark was introduced above and it perfectly complies with the state of the grasslands established in 2008. If we consider in addition to this the fact that low vegetation areas have developed as a result to grazing that had been started in several fields, then the reason of the growth in the population size becomes more obvious. In the course of years, ideal conditions have developed for the Skylark respecting its breeding, foraging and hiding needs. Having considered all these factors we stated that the year 2008 differed significantly from any other year, which is clearly demonstrated by the number of territories on the 12 plough land parcels investigated in the period between 2004 and 2008.

4. Conclusion

By analyzing the period between 2004 and 2006, it can be stated that the areas dominated by extremely tall weeds evolved in the first year following grassland restoration, are not favourable for the Skylark population. While the size of the Skylark population has grown everywhere, except in one of the six arable fields used as control area, a fall in the population size was experienced in the restored fields from 2005 to 2006. Because of the heavy precipitations in 2006, the effect of the grassland restoration could not be shown in the first year; the extremely rainy year might have concealed that to a large extent.

By investigating the period between 2004 and 2008, we stated that the year 2008 significantly differed from the others. The identification of 64 home ranges has also indicated this, as the second largest figure was only 32 in 2006. The Skylark prefers those dryer patches of the habitat having shorter vegetation, from where it is able to look out, and, respectively, where it finds food as it feeds on seeds. These types of grasslands have been established by this year. In addition to that, grazing of sheep and cattle has also started in several places, resulting in the development of quite low turf heights alternating with higher types of grassland in a mosaic-like structure. This way breeding, foraging and hiding places alike evolved for the species within relatively small, mosaic-like areas. Many studies pointed out that the abundance of the Skylark in adjacent, extensively and intensively cultivated areas shows only a small difference in favour of the extensive arable fields [21, 22]; the population data experienced in 2008 support this. The changes at landscape level could be even better assessed by the investigation of other farmland bird species.

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