INVESTIGATION OF THE SPRING MIGRATION OF THE EURASIAN WOODCOCK (*Scolopax rusticola* Linnaeus, 1758) IN ROMANIA

BENDE Attila, CSANÁDY Viktória, KULCSÁR Róbert, LÁSZLÓ Richárd

Abstract. We have only little information on features of woodcocks' spring migration in the territory of Romania – apart from certain hunting data. The research method was to count the features of spring migration both in flat and hilly areas on 10 observation stations. We supposed that the number of observed (seen or heard) woodcocks was in proportion with the temporal change of the number of migrating birds, so the temporal alterations of observation numbers would reflect the dynamism of migration. The non-linear regression method was used to model the conformation of the witnessed or heard data and the general observations (n=253). We see that, during spring migration (between the second decadal of February and middle of March), the observed number of birds showed a growing tendency – in varying degrees. On the grounds of our model we calculated the observational maximum and it came out that the peak of migration was on 14th March. The analysis of variance showed a statistically appraisable difference in peaks of migration between the observation points in flatlands and hilly areas. In mountainous areas the peak of migration was on 10th of March whereas on flatlands it was on the 20th of March. It verifies the shift in the process of migration in these different geographical elevation types. In accordance with expectations in the case of seen and heard birds' numbers we experienced significant differences (p=0.000), whereas the interaction between the areas and observations was not significant (p=0.135). During the analysis of the relationship between the observations and the observation places we concluded that the number of observed birds is independent from the areas, so there is no significant discrepancy (p=0.461). We must mention that we saw differences between areas in the frequency values, though the experienced frequency distributions can be considered the same in each observation point. It is true that drawing statistically based conclusions on examination of territorial and temporal differences of migration needs a lot of observation data collected through years. Well, the results of our non-representative study with a small item number can be valuable when seeking to expand the knowledge of woodcock migration.

Keywords: Woodcock, Romania, synchronized observation, spring migration, non-linear regression.

Rezumat. Studiul migrației de primăvară a sitarului (*Scolopax rusticola* Linnaeus, 1758) în România. Cu excepția cotelor de recoltă, în privința populațiilor de sitari de pădure care traversează România dispunem de o cantitate mică de informații de așa natură încât să ne permită să tragem concluzii privind caracteristicile migrației de primăvară a acestei specii. În cursul cercetării am analizat caracteristicile migrației de primăvară prin numărare în sincron efectuată la zece puncte de observație din zone cu relief plat și zone alpine. Am emis ipoteza că numărul sitarilor de pădure observați (văzuți și auziți) este proporțional cu variația temporală a efectivului de păsări care traversează țara în timpul migrației de primăvară, deci evoluția temporală a numărului de păsări observate reflectă dinamica migrației. Pentru a modela evoluția temporală a păsărilor auzite, văzute, respectiv observate în total (n=253) s-a folosit o metodă bazată pe regresie neliniară. Am constatat că în timpul migrației de primăvară, care începe în cea de-a doua decadă a lunii februarie, s-a putut observa o tendință ascendentă până la jumătatea lunii martie în privința numărului de păsări observate, deși în măsuri variabile. Maximul de observație referitor la toate datele calculate pe baza modelului, adică vârful migrației, poate fi pus la 14 martie. Analiza de varianță a relevat o diferență semnificativă din punct de vedere statistic în ceea ce privește evoluția temporală a punctului culminant al migrației între punctele de observație din zonele cu relief plat și cele din zone alpine. Data tipică a punctului culminant al migrației în cazul punctelor de observație din zone montane a fost 10 martie, în timp ce în zonele cu relief plat aceasta a fost 20 martie, deci chiar și în cazul acestui studiu realizat la scară mică se poate demonstra diferența în ceea ce privește desfășurarea migrației sitarilor de pădure din zonele cu relief plat și din cele alpine. Conform așteptărilor, s-au constatat diferențe semnificative în ceea ce privește numărul păsărilor văzute și a celor auzite (p=0,000), în timp ce interacțiunea dintre zone și observații nu a fost una semnificativă (p=0,136). Analizând relația dintre semnalări și puncte de observație, am constatat că numărul de păsări observate este independent de zonă, adică nu a existat o diferență semnificativă (p=0,461), deși magnitudinea valorilor de frecvență a diferit în mod semnificativ în diferitele zone, însă distribuțiile frecvenței constatate la diferitele puncte de observație pot fi considerate identice. Desigur, pentru a putea trage concluzii întemeiate din punct de vedere statistic, ar fi necesare date observaționale din mai mulți ani pentru a examina diferențele spațiale și temporale în privința migrației. Cu toate acestea, rezultatele acestui studiu pe scară mică, nereprezentativ la nivel național, pot fi valoroase din punctul de vedere al cunoștințelor legate de migrația sitarului de pădure.

Cuvinte-cheie: sitar de pădure, România, observații sincron, migrație de primăvara, regresie non-lineară.

INTRODUCTION

Due to the results of uncertain population estimates, opinions on the conservation status of the woodcock are divided. According to ROSE & SCOTT (1997), the size of the European population is 16 million, and according to DELANY & SCOTT (2006) it is 10–25 million, while more recent data suggest that the population size is between 13 and 17 million (BIRDLIFE INTERNATIONAL 2015, 2016). Based on the above data, woodcock populations can be considered stable, even if lower estimates are considered relevant. There is relatively little scientific knowledge about the species in the Romanian ornithological literature. Only a few enthusiastic hunters and ornithologists have researched and are researching this species in the country, so knowledge of spring and autumn migration, nesting, age and sex relations is incomplete. Woodcocks typically appear in larger numbers in Romania during the autumn and spring migrations, but they nest as well, with an estimated 600–5,000 birds nesting in the country each year (MUNTENAU 2002; BIRDLIFE INTERNATIONAL, 2015; PETROVICI, 2015).

Following the accession to the European Union in 2017, in accordance with Article 4 (2) and Article 7 (4) of the EU Birds Directive (79/409/EEC), woodcock may not be hunted in the spring in Romania, as the Directive prohibits hunting during the migration/roding period to the breeding area or during the breeding season. Woodcock is listed in the Annex II/1 of the Directive (***, 2009). Therefore, it is considered game bird species in Europe, so the possibility of autumn/winter utilization remained. In the recent period, during the autumn/winter hunts (1 Sept. - 28 Feb.), an average of 4,000–6,000 specimens per year were dropped in the country (TOKE et al. 2006, 2007). However, the age and gender, spatial and temporal patterns of the hunting bag were not investigated. With the exception of hunting bag records, we do not have any information on the populations migrating through Romania, which would allow us to draw conclusions about the migratory characteristics of this species, so our data can provide an interesting addition to the migratory conditions of woodcocks in Romania.

MATERIAL AND METHOD

Collection of woodcock migration observation data during spring season

Observations were made at ten sites, (Fig. 1) between 19 February and 25 March, twice a week during dawn and dusk roding.

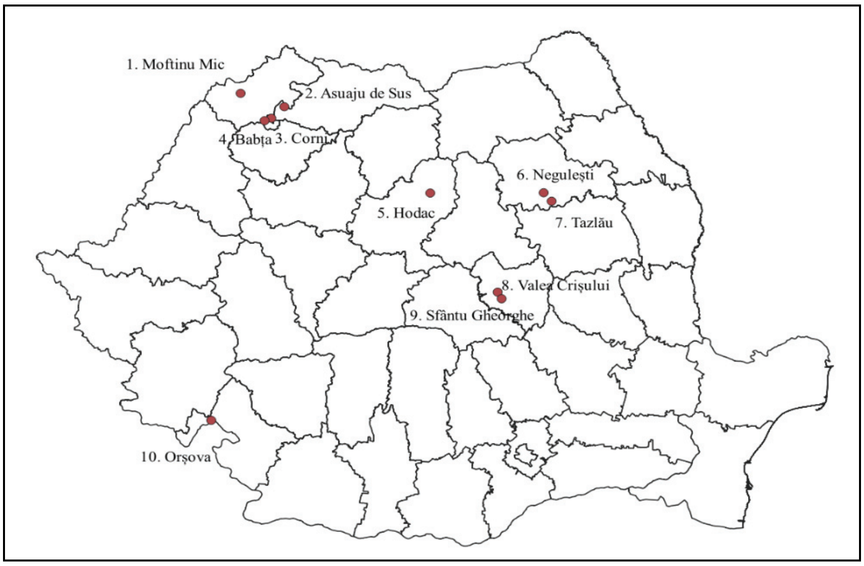

Figure 1. Location of designated woodcock *(Scolopax rusticola)* observation points
1. Satu Mare-Moftinu Mic (Kismajtény), 2. Maramureş-Asuaju de Sus (Felsőszivágy),
3. Maramureş-Corni (Somfalu), 4. Satu Mare-Babţa (Bábca), 5. Mureş-Hodac (Görgényhodák),
6. Neamţ-Neguleşti, 7. Neamţ-Tazlău (Tázló), 8. Covasna-Valea Crişului (Sepsikőröspatak),
9. Covasna-Sfântu Gheorghe (Sepsiszentgyörgy), 10. Mehedinţi-Orşova (Orşova).

During our investigation, multiple observations at each individual observation site can be ruled out due to their significant distance. The residence time of birds is only a few days on average, so, between the two observations per week, the birds are likely to have left the area. However, multiple counts of the same individual birds at a specific roding cannot be ruled out (FERRAND 1993; HOODLESS et al. 2007; HOODLESS et al. 2009). In order to have a uniform data collection protocol, we used the same datasheet at each site, whose data were recorded in a database after the observations.

The observers recorded the number of birds seen and heard, as well as the weather conditions of the observation. Due to the COVID-19 pandemic during the spring of 2020, the observations had to be interrupted at the end of March, so the dataset characterizing the finish of the migration is incomplete although the dynamic course can be assessed based on the data. In order to characterize the migration course, a nonlinear regression model was fitted to the observation datasets recorded at the observation sites. Using the mathematical model, we determined the parameters (b0; b1; b2; b3) and the nonlinear correlation coefficients. Also, we estimated the maximum location of the point series and the beginning of the migration process finish. The mathematical formula of the chosen model was as follows:

$$\hat{y} = \frac{ax}{b + (cx)^d}$$

The function starts from the origin and is positive in the infinite asymptotic; the value of the exponent d is a positive non-integer value. The model we have chosen satisfies the not necessarily symmetric nature of the migration contrary to the Gaussian curve. The extreme value of the function – which is the peak of the migration - can be determined by deriving the function and finding the location of the maximum, the time of the peak of the migration.

The location of the maximum: $x = \frac{1}{c} \sqrt[d]{\frac{b}{d-1}}$, where x is the independent variable, the distance of the observation days from the start time of the observations (19 February).

The relationship between observation sites and observations was analysed using a test of independence.

During the evaluation of the observation data (number of birds seen and heard), we examined by double-ended analysis of variance whether there was a significant difference between the expected values of each observation site and whether there was a significant difference between the number of specimens seen and heard.

We performed the mapping of the sampling sites with the QGIS (3.8.0) Geographic Information System software, while the statistical analysis of the data and their graphical representation were performed with Microsoft Excel 2016 and Statistica 13.

RESULTS

During our investigation, we started from the correlation that the number of observed (seen and heard) woodcocks is proportional to the change in the number of birds over time migrating during the spring migration, so the results of the synchronous counting adequately reflect the migration dynamics. At the ten observation points, a total of 106 woodcocks were seen and 42 woodcocks were heard during the evening observations, while a total of 78 birds were seen and 27 birds were heard by the data collectors during the morning observations.

Characteristics of migration dynamics

We examined by the regression procedure whether the development of the total number of specimens (seen and heard birds) is determined by the number of birds seen or rather heard.

The models obtained as a result of the function fitting, their parameters, and the values of the regression coefficient are given in Table 1.

Table 1. Applied models, their parameters, regression coefficients.

Dependent variable	**Applied models** (var_1: sampling time)	**Parameters**				**Regression coefficients**
		b_3	**b_2**	**b_1**	**b_0**	
Birds heard (var_2)	$var_2=b_3*var_1/(b_2+(b_1*var_1)\^b_0)$	40,358	87,723	0,084	?62	0,794
Birds seen (var_3)	$var_3=b_3*var_1/(b_2+(b_1*var_1)\^b_0)$	94,785	70,483	0,103	537	0,775
All observations (var_4)	$var_4=b_3*var_1/(b_2+(b_1*var_1)\^b_0)$	158,275	86,783	0,107	3,563	0,815

The value of the correlation coefficient gives the weakest value (R = 0.775) when the function is fitted to the dataset of the seen specimens, which can be explained by the standard deviation of the basic data although this value does characterize the process with sufficient certainty. However, the differences in the parameters are more significant in the case of the birds heard compared to the parameters of the birds seen and the total number of specimens, which can also be explained by the small number and standard deviation of the basic dataset.

During the modelling of the migration, there was difference in the observation maximum of the birds seen and heard. For birds seen, the maximum fell to the 25th sampling day (14 March), while for birds heard it fell to the 26th sampling day (15 March). Taking all data into account, the migration peaked on the 25th sampling day (14 March). However, due to the standard deviation of the small number of data series and the loss of data as a result of the forced interruption of observations, the function fitted to the aggregate data series indicates an extreme value earlier than the actual local maximum. Taking into account the maximum determined by the model and derived from the baseline data, based on our interval estimate, the peak of migration can happen during the second decade of March (Fig. 2).

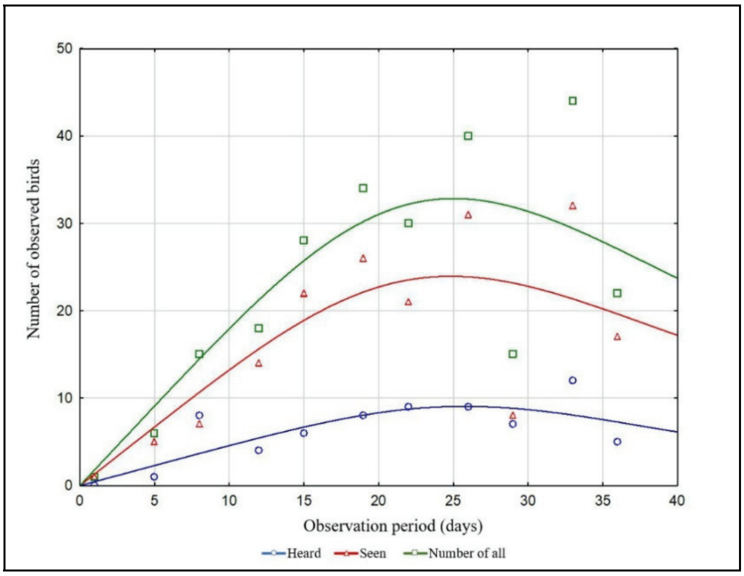

Figure 2. Time course of the number of all, seen, and heard woodcocks during the observation period.

The relationship between the observations and the observation sites was analysed by test of independence. We assumed that the distribution of the number of specimens (seen/heard) was independent of the sampling area. According to the null hypothesis of the study, empirical frequencies are equal to theoretical frequencies. Using the 5% error rate in our study, $\chi^2 = 8.748$ (df = 9) did not exceed the critical value ($\chi^2k = 16.92$), so the observations are independent of the areas, meaning there is no significant difference ($p = 0.461$) although the order (magnitude) of the frequency values differs significantly in each area, and the frequency distributions observed at each observation point can be considered similar (Fig. 3).

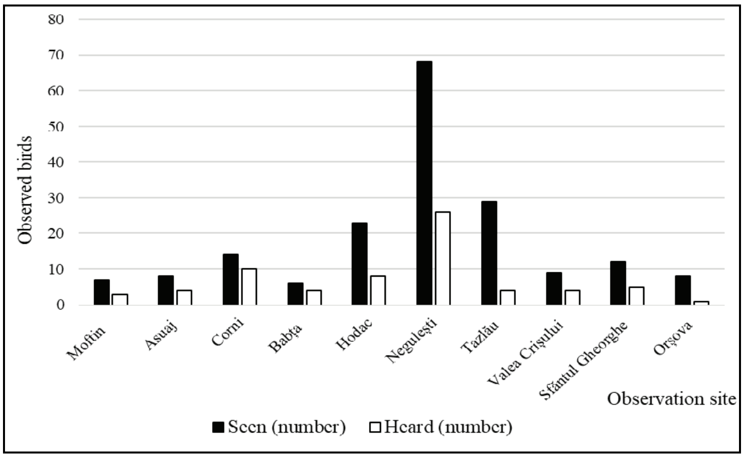

Figure 3. Number (n = 253) of woodcocks seen and heard during the observation period at each observation site.

We also examined whether there was a statistically significant difference among the values of the observations expected at the ten observation sites, and whether there was a significant difference among the theoretical numbers of specimens seen and heard. According to the null hypothesis of the study, the expected observation value of each observation area is constant, and the number of birds seen is equal to the number of birds heard and there is no interaction between the two factors (area and observation). We excluded the Negulești sampling area from the analysis of variance because the observation value of the area is outside the double standard deviation of the observation values of all the observation sites. The results of the analysis of variance are shown in Table 2.

Table 2. The result of the two-way analysis of variance.

Factors	Degrees of freedom	Variables			
		var_3 SS	var_3 MS	var_3 F	var_3 p
Variable of area (var_1)	8	29,697	3,7122	1,7766	0,091
Variable of observations (var_2)	1	40,119	40,1191	19,2005	0,000
Interaction of areas and observations (var_1*var_2)	8	26,655	3,3318	1,5946	0,136
Error	98	204,769	2,090	–	–
Total	115	307,060	–	–	–

The results clearly show that the interaction between the areas and the observations is not significant ($p = 0.136$), while there is a significant difference in the numbers of birds seen and heard ($p = 0.000$). In the case of the area variable, there is no significant difference ($p = 0.091$), but if the multiple extent test (Duncan test) is performed, at 5% significance level the migration dynamics show a time difference at some sampling sites. The observation sites can be divided into two groups based on the peak of the migration over time. In the case of samples from the Covasna and Neamț counties the maximum date is 10 March, while at the sampling points in the Satu Mare, Maramureș and Mehedinți counties 20 March was the typical date of the migration maximum, so a statistically evaluable phase delay can be shown in the culmination of woodcock migration in mountainous and lowland regions based on our data. In the case of Hodac, no observation point could be clearly classified, nor at Babța, where, due to the pandemic situation, observations had to be interrupted earlier.

DISCUSSIONS AND CONCLUSIONS

Based on the results of the synchronous counting at the ten observation points, it can be stated that during the spring migration starting in the second decade of February, the number of observed birds showed an increasing trend until mid-March, so the migration can peak by the second decade of March based on the overall data from the ten observation points. Comparing the results of the synchronous counting in Romania and the Hungarian Woodcock Monitoring, it can be stated that the course of the migration of the species in Romania shows a similar dynamic to the Hungarian data (FARAGÓ et. al. 2011, 2012a, b, c, 2014, 2015a, b, 2016; BENDE, 2021), but its peak can be dated to about 5–15 days earlier than the maximum experienced in Hungary (third decade of March). Based on the observation data recorded at the designated observation points in the lowland and mountainous regions and the difference detected by the analysis of variance, our study results confirm the phase-delayed woodcock migration previously reported in the Romanian literature (MĂTIEȘ & MUNTEANU, 1976, 1979, 1980). Based on our results, the maximum experienced at the designated sampling sites in the lowland region is 20 March, while in the mountainous areas it is estimated to be 10 March. Examining the relationship between birds and observation sites, we concluded that the observations were independent of the sampling area although the order (magnitude) of the frequency values varied significantly in each area, and the frequency distributions observed at each observation point can be considered similar.

One single year is not enough for a statistically reliable description of the spring migration characteristics of woodcocks. Naturally, with such a small number of items ($n = 253$) it is not possible to find out the reasons for the differences emerging during the migration. We could only do so with a nationwide time-series dataset including a sufficiently large number of items, and at the same time, we would like to draw attention with our study to the need for wildlife biology research in connection with this species.

ACKNOWLEDGMENT

We would like to extend our gratitude to our hunter and forestry colleagues – Cojocaru Mihaela, Teslovan Cosmin, Teslovan Ionaș, Bíró Szabolcs, Téglás Szabolcs, Mogos Remus, Dragoș Zoltan, Gherman Remus, Băbțan Nicolae, Barra István Attila –, who made it possible for us to conduct our investigation during the spring migration, with their own observation data. We thank Dr. János Botond Kiss for his selfless help in translating the Romanian texts and publishing the study.

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Bende Attila[1], Csanády Viktória[2], Kulcsár Róbert[1], László Richárd[1]
[1]University of Sopron, Faculty of Forestry. Institute of Wildlife Management and Vertebrate Zoology. Sopron 9400, Bajcsy-Zsilinszky út 4. Hungary.
[2]University of Sopron, Faculty of Forestry. Institute of Mathematics. Sopron 9400, Bajcsy-Zsilinszky út 4. Hungary.
* Corresponding author Attila Bende, E-mail: bende.attila.tibor@uni-sopron.hu

Received: April 15, 2021
Accepted: August 17, 2021