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PASSERIFORMES AS INDICATORS OF BIODIVERSITY CONSERVATION IN THE FRONTLINE ZONE OF SUMY REGION

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Abstract

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Passeriformes are a sensitive group of birds that play a role as indicators of biodiversity, pollution, and environmental change. The military operations taking place in the Sumy region are the main threat to the region's biodiversity. Undoubtedly, the consequences of these threats can be reflected in a decrease in numbers, phenological changes, and changes in trophic interaction. However, due to their properties and ability to adapt, I assume that birds of the Passeriformes can respond to these environmental changes in different ways. Given the mosaic of different vegetation types and the presence of many transitional areas between them, the study area was divided into five habitats: household plots, pine forest, Vorsklytsia River, pastures, and agrocenoses. During the research period, 48 species of birds belonging to 18 families and 36 genera were identified. This study allowed us to confirm the hypothesis that similar species of birds are found in the three biotopes (pastures, agrocenoses, and household plots) and that most of them may have similar food resources in their diet. The results of grouping in the space of projections of the principal components, PC1 and PC2, taking into account the measured indicators of the number of representatives of the Passeriformes in relation to different habitats, showed a strong positive relationship between the number of bird species of the Passeriformes in pastures and agrocenoses, and the average relationship was determined for household plots and the Vorsklytsia River. A negative correlation was found for the pine forest, which shows a fairly high number of species as well as the originality of the habitat. The basis of the Passeriformes population was formed by sedentary birds. The highest proportion of sedentary species was found in household plots (31.3%) and the pine forest (31.3%). Dendrophiles were the most numerous group: in the pine forest, 95.2% (of all species), household plots, 66.7%, pastures, 50%, and Vorsklytsia River, 37.5%. Hollow-nested species had a high proportion of 57.1% in the pine forest, crown-nested species 46.7% also in the pine forest, shrubs 50% in household plots, and ground-shrubs 60% near the Vorsklytsia River. The highest proportion of species was found for entomophagous birds (30.3%) and polyphagous birds (31.4%) in the pine forest, while the phytophagous bird group had the highest proportion of 50% in the household plots.

Key words: birds, biotopes, Sumy region, ecological groups of birds, indicator species, military actions.

Introduction

The conservation of biological and landscape diversity is a prerequisite for the sustainable development of every country. In recent years, Ukraine has suffered direct destruction and loss of habitats (Udovenko et al., 2023; Polischuk, 2023). The consequences of military actions in habitats in the Sumy region in 2023 include mines, tree felling, fires from shelling and deliberate arson of the grass layer, craters in the places where shells fell, remnants of defensive structures (trenches, shelters, and trenches), contamination of the territory with the remains of destroyed military equipment, in particular with heavy metals – Mn, Zn, Cu, Ni, Fe, Cd, Pb (Zaitsev et al., 2022), fuels and lubricants, destruction of soil cover, pollution of water resources, an increase in the number of stray animals, and a lack of preventive measures to prevent disease outbreaks.

Since the beginning of the full-scale invasion, Soldatske village and its surroundings in the Okhtyrka district of the Sumy region have been subjected to hailstorms and bombings. All this led to devastating consequences. Many animals became victims of shell explosions, rocket attacks and mine, and tripwire explosions; numerous fires caused damage to internal organs as a result of shock waves and stress caused by the noise of the fighting; a large number of animals had to flee from the "hot" spots to avoid death. This raises the important question of determining the ability of birds to withstand threats. Research in Arizona, USA (Ellis, 1981) showed that low-flying military jets and sonic booms do not affect nesting birds of prey. In similar studies (Barron et al., 2012) conducted at military training grounds, it was found that the species *Cardinalis cardinalis* (Linnaeus, 1758), *Vireo bellii* (Audubon, 1844), *V. atricapilla* (Woodhouse, 1852), *V. griseus* (Boddaert, 1783), *Polioptila caerulea* (L., 1766), *Mimus polyglottos* (L., 1758), *Passerin aciris* (L., 1758), and *Peucaea aestivalis* (Lichtenstein, 1823) can successfully nest in areas with high military activity. In this regard, assessing the state of bird species diversity is a fairly reliable way to bioindicate the conservation of natural complexes (Trindade-Filho et al., 2012; Deoniziak et al., 2022).

The aim of the study is to investigate the spatial distribution of Passeriformes species in the frontline zone of Soldatske village and its environs in the Okhtyrka district of the Sumy region.

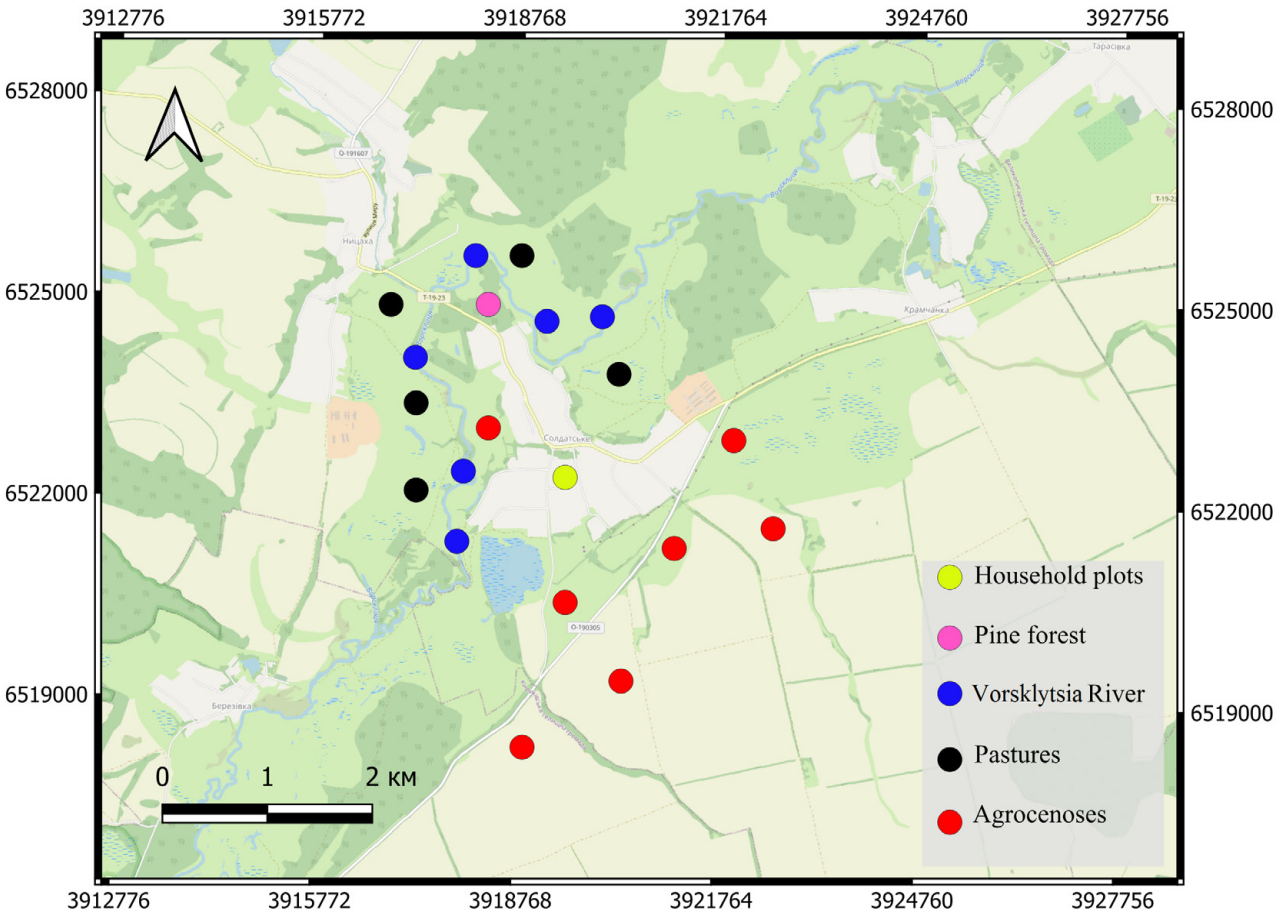

Fig. 1. Map of the studied habitats in Soldatske village.

Material and methods

The study of the species diversity of Passeriformes, conducted in Soldatske village, located in the frontline zone, has not been conducted before. The first observations of birds in the village began in 2019, but the data obtained were not published before. Since then, biotechnical measures have been taken to hang plastic artificial nesting boxes, which are still gaining popularity. The village of Soldatske is 36 km from the village of Klymentove and 23 km from the village of Kamianka, where together with ornithologists Knysh, Chaplygina, Yuzyk, graduate students, and students of H. S. Skovoroda Kharkiv National Pedagogical University, from 2009 to 2021, we conducted monitoring work on birds in artificial nesting boxes (Chaplygina, 2015; Chaplygina et al., 2019; Yarys et al., 2021a,b, 2024) made of board material. Today, these areas are dangerous. However, a detailed study of Passeriformes is still relevant (Yarys et al., 2021a,b, Yarys, Chaplygina, 2022; Melnikov, Yarys, 2022), and hence, in May 2023, I resumed work on determining the species diversity of birds in Soldatske village and its surroundings.

Taking into account the rather pronounced mosaic of different vegetation types and a large number of transitional areas between them, the study area was divided into five biotopes that best reflect Soldatske village and its surroundings: household plots (route length 8.43 km; study area 2.31 km^2), pine forest (3.36 km; 0.53 km^2), Vorsklytsia river (6.02 km), pastures (8.62 km; 1.9 km^2), and agrocenoses (4.52 km; 0.44 km^2) (Fig. 1).

The number and distribution of birds were determined by route counting. The principal component analysis (PCA) of the main characteristics of the habitats of Soldatske village, on which the number of birds in the communities may depend, was carried out. To quantify the species diversity of passerines, we used commonly used indices. The Simpson's species dominance index (c) was estimated in the range of 0–1, where 0 is no species dominance and 1 is complete dominance. Shannon's diversity index (H) was calculated based on the results of an increase in the value (on a scale from 0 to 2.7), which means an increase in species diversity, and for the Pielou Equitability (E), values from 0 to 1 were taken into account. For real communities, this index rarely exceeds 0.8. Margalef's index (D_{Mg}) and Menhinick›s index (D_{Me}) reflect the species richness of a particular area, so the higher the indices, the higher the species richness of a particular area.

The strength of the association between bird species and habitats was determined using the indicator value index (IndVal) (De Caceres, Legendre, 2009). The horizontal lengths show the contribution of individual species as indicator values based on the combination of relative abundance, relative density, and relative frequency, and the p-values are shown by the color of the bar

Table 1. Ecological features of the spatial distribution of Passeriformes in the village of Soldatske in spring 2023.

View	Migration status	Environmental group	Type of bird food	Types of nesting	Biotopes				
					Household plots, persons	Pine forest, persons	Vorsklytsia River, persons	Pastures, persons	Agrocenoses, persons
Riparia riparia L.	N/M	S	E	Dn	–	–	4.5	0.6	–
Hirundo rustica L.	N/M	S	E	A	4.3	–	3.6	0.4	0.4
Delichon urbicum L.	N/M	S	E	A	1.4	–	0.6	–	–
Galerida cristata L.	S	C	P	G	–	–	–	0.1	1.3
Alauda arvensis L.	N/M/W	C	P	G	–	–	–	0.1	–
Anthus trivialis L.	N/M	C	E	G	–	0.9	–	–	–
Motacilla flava L.	N/M	C	E	G	–	–	–	0.2	–
Motacilla citreola Pall.	N/M	C	E	G	–	–	0.9	–	–
Motacilla alba L.	N/M	L	E	A	1.2	–	0.7	–	–
Lanius collurio L.	N/M	D	E	Sh	0.4	–	–	–	–
Oriolus oriolus L.	N/M	D	E	Cr	–	0.9	–	–	–
Sturnus vulgaris L.	N/M/W	D	P	H	2.5	–	1.3	1.5	0.9
Garrulus glandarius L.	S	D	P	Cr	–	0.6	–	–	–
Corvus cornix L.	S	D	P	Cr	1.6	–	1.2	0.5	–
Corvus corax L.	S	D	P	Cr	0.6	0.9	–	0.3	–
Locustella fluviatilis Wolf.	N/M	L	E	Gs	–	–	0.3	0.1	–
Acrocephalus schoenobaenus L.	N/M	L	E	Gs	–	–	0.2	–	–
Acrocephalus arundinaceus L.	N/M	L	E	Gs	–	–	0.8	–	–
Sylvia atricapilla L.	N/M	D	P	Sh	–	0.5	–	–	–
Sylvia borin Bodd.	N/M	D	P	Gs	0.8	–	–	–	–
Phylloscopus trochilus L.	N/M	D	E	G	0.2	–	–	–	–
Phylloscopus collybita Vieill.	N/M/RW	D	E	Gs	–	0.6	–	–	–
Phylloscopus sibilatrix Bechst.	N/M	D	E	G	0.2	0.9	–	–	–
Ficedula albicollis Temm.	N/M	D	E	H	–	5	–	–	–
Muscicapa striata Pall.	N/M	D	E	Cr	–	0.6	–	–	–
Saxicola rubetra L.	N/M	C	E	G	–	–	–	0.1	–
Phoenicurus ochruros Gm.	N/M/RW	S	P	A	0.7	–	–	–	–
Erithacus rubecula L.	N/M/W	D	E	G	–	1.8	–	–	–
Luscinia luscinia L.	N/M	D	E	G	0.4	–	0.3	–	–
Luscinia svecica L.	N/M	C	P	G	–	–	0.7	–	–
Turdus merula L.	N/M/W	D	P	Cr	–	2.8	–	–	–
Turdus philomelos Brehm	N/M/RW	D	P	Cr	0.3	0.6	–	–	–
Poecile palustris L.	S	D	P	H	–	0.6	–	–	–
Poecile montanus Baldenst.	S	D	P	H	–	0.3	–	–	–
Periparus ater L.	S	D	P	H	–	0.6	–	–	–
Cyanistes caeruelus L.	S	D	E	H	–	3	–	–	–
Parus major L.	S	D	P	H	4.9	10.7	2.3	–	–
Sitta europaea L.	S	D	E	H	–	1.2	–	–	–
Certhia familiaris L.	S	D	E	H	–	0.6	–	–	–
Passer domesticus L.	S	S	P	A	29.1	–	–	–	–
Passer montanus L.	S	S	P	A	17.5	–	3.8	5.9	9.7
Fringilla coelebs L.	N/M/W	D	P	Cr	–	3.3	–	–	–
Chloris chloris L.	S	D	P	Sh	0.5	3.3	–	–	–
Spinus spinus L.	S	S	E	Cr	0.1	–	–	–	–
Carduelis carduelis L.	S	D	Ph	Sh	0.5	–	–	1.5	–
Acanthis cannabina L.	S	D	Ph	Cr	0.7	–	–	–	–
Emberiza calandra L.	S	D	Ph	G	–	–	0.5	–	–
Emberiza citrinella L.	S	D	Ph	G	0.2	–	0.5	–	–

Notes: *migration status:* N – nestingbirds; S – sedentary birds (individuals of the species can be found throughout the year); W – wintering birds (occurs *en masse* in winter); RW – rarely wintering birds; and M – migratory birds (spring or winter migrant); *environmental group:* D – dendrophiles; C – campophiles; L – limnophiles; S – sclerophiles; *types of nesting:* Cr – crown-nesting birds; Sh – shrubby birds; Gs – ground-shrub (birds that build their nests in ground vegetation up to 0.5 m); H – hollow-nesting birds; G – ground-nesting birds; A – anthropogenic nesting birds (species that use only anthropogenic structures for nesting in these habitats); and Dn – dens nesting birds; *type of bird food:* Ph – phytophages; E – entomophages; and P – polyphages.

(0–100), which represents the Monte Carlo significance test of the observed maximum indicator value for each species. Rectangles represent the highest values of the indicator. The larger the dot, the more significant the *p*-value of the species.

Statistical calculations were performed in Microsoft Excel, OriginPro 2022 v.9.9.0.225 (SR1), Past 4.13. The QGIS software package was used for the work.

Results and discussion

It is known that the spatial structure of bird complexes depends on the nature of habitats, especially the mosaic of microhabitats, the nature and condition of vegetation, the level of abundance of each species, and their nesting neighborhood (Koshelev, 2018).

During the research period, 48 species of birds belonging to 18 families and 36 genera were found in Soldatske village: Hirundinidae (3), Alaudidae (2), Motacillidae (4), Laniidae (1), Oriolidae (1), Sturnidae (1), Corvidae (3), Locustellidae (1), Acrocephalidae (2), Sylviidae (2), Phylloscopidae (3), Muscicapidae (9), Paridae (5), Sittidae (1), Certhiidae (1), Passeridae (2), Fringillidae (5), and Emberizidae (2).

The number of birds in different habitats of the frontline zone is heterogeneous. There are 21 species recorded in the pine forest, 21 in household plots, 16 near the Vorsklytsia River, 12 in pastures, and the smallest number of birds in agrocenoses–4 (Table 1).

According to the specifics of spatial distribution, the observed passerines can be divided into four groups:

- in 4 biotopes (*Hirundo rustica*, *Sturnus vulgaris*, and *Passer montanus*);
- in 3 biotopes (*Corvus cornix*, *C. corax*, and *Parus major*);
- in 2 biotopes (*Riparia riparia*, *Delichon urbicum*, *Galerida cristata*, *Motacilla alba*, *Locustella fluviatilis*, *Phylloscopus sibilatrix*, *Luscinia luscinia*, *Turdus philomelos*, *Chloris chloris*, *Carduelis carduelis*, and *Emberiza citrinella*);
- in 1 biotope (*Alauda arvensis*, *Anthus trivialis*, *Motacilla flava*, *M. citreola*, *Lanius collurio*, *Oriolus oriolus*, *Garrulus glandarius*, *Acrocephalus schoenobaenus*, *A. arundinaceus*, *Sylvia atricapilla*, *S. borin*, *Phylloscopus trochilus*, *Ph. collybita*, *Ficedula albicollis*, *Muscicapa striata*, *Saxicola rubetra*, *Phoenicurus ochruros*, *Erithacus rubecula*, *Luscinia svecica*, *Turdus merula*, *Poecile palustris*, *P. montanus*, *Periparus ater*, *Cyanistes caeruelus*, *Sitta europaea*, *Certhia familiaris*, *Passer domesticus*, *Fringilla coelebs*, *Spinus spinus*, *Acanthis cannabina*, and *Emberiza calandra*).

It is obvious that most species of birds occur in their typical habitat, but there are species that, due to certain conditions (e.g., weather conditions, lack of adequate food resources, predators and anthropogenic factors), are forced to look for areas with suitable places for nesting or foraging.

The flexibility of birds' behavior in searching for food in different habitats affects the understanding of predicting environmental changes (Cueto, De Casenave, 2002). This study allows us to confirm the hypothesis that in the three biotopes (pastures, agrocenoses and household plots), similar bird species are found, and for most of them similar food resources may be included in the diet. However, Cueto and De Casenave (2002) proved that bird species (*Parula pitiayumi*, *Polioptila dumicola*, *Serpophaga subcristata*, and *Elaenia parvirostris*), on the contrary, differed in the choice of microhabitats in old coastal forests. The scientists also claim that their findings illustrate the importance of deforestation for bird density. Our results show that many species of birds prefer habitats with a sufficiently high number of trees (pine forests and gardens on private plots).

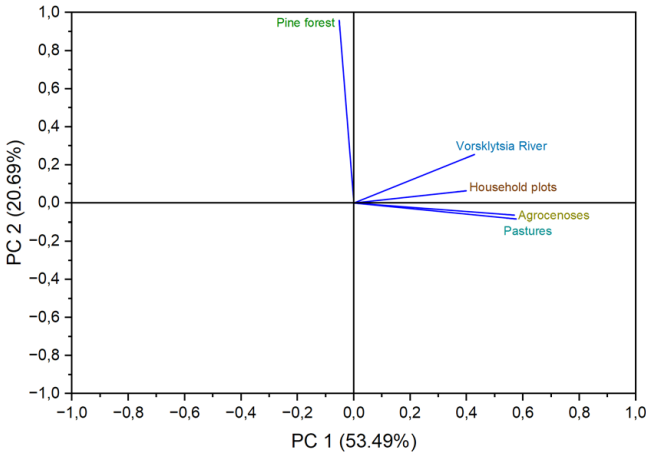

Fig. 2. Analysis of Passeriformes relationships with habitat characteristics of Soldatske village.

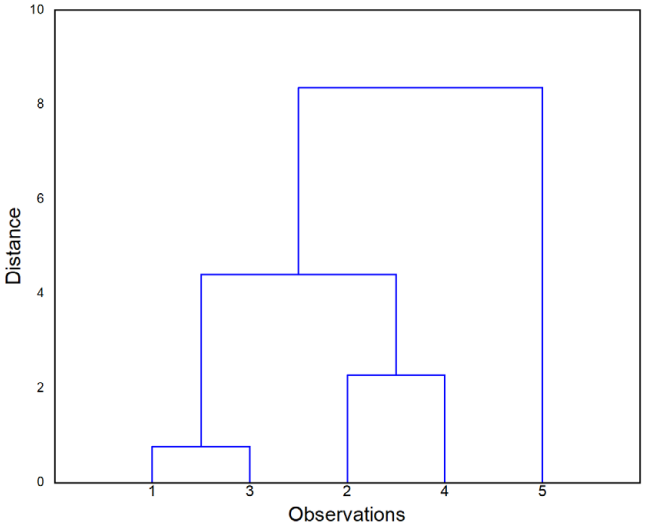

Fig. 3. Dendrogram of similarity of species diversity of Passeriformes. Soldatske village: 1 – household plots; 2 – pine forest; 3 – Vorsklytsia River; 4 – pastures; and 5 – agrocenoses.

Figure 2 shows the results of grouping in the space of projections of the principal components, PC1 and PC2, taking into account the measured indicators of the number of representatives of the order Passeriformes in relation to different habitats.

The data obtained showed that variants contained in one quadrant are positively related, and in opposite quadrants, negatively. Thus, a strong positive correlation was found between the number of Passeriformes species in pastures and agrocenoses, with an average correlation for household plots and the Vorsklytsia River. A negative relationship was established for the pine forest, which shows a fairly high number of species as well as the originality of the habitat.

Table 2. Alpha diversity of Passeriformes in different habitats of Soldatske village.

Indexes	Household plots	Pine forest	Vorsklytsia River	Pastures	Agrocenoses
c	0.3	0.1	0.1	0.3	0.6
H	1.8	2.5	2.3	1.6	0.7
E	0.3	0.6	0.7	0.4	0.5
D_{Mn}	2.5	3.3	2.4	3.6	1.1
D_{Mg}	5	6	5.7	5.6	1.3

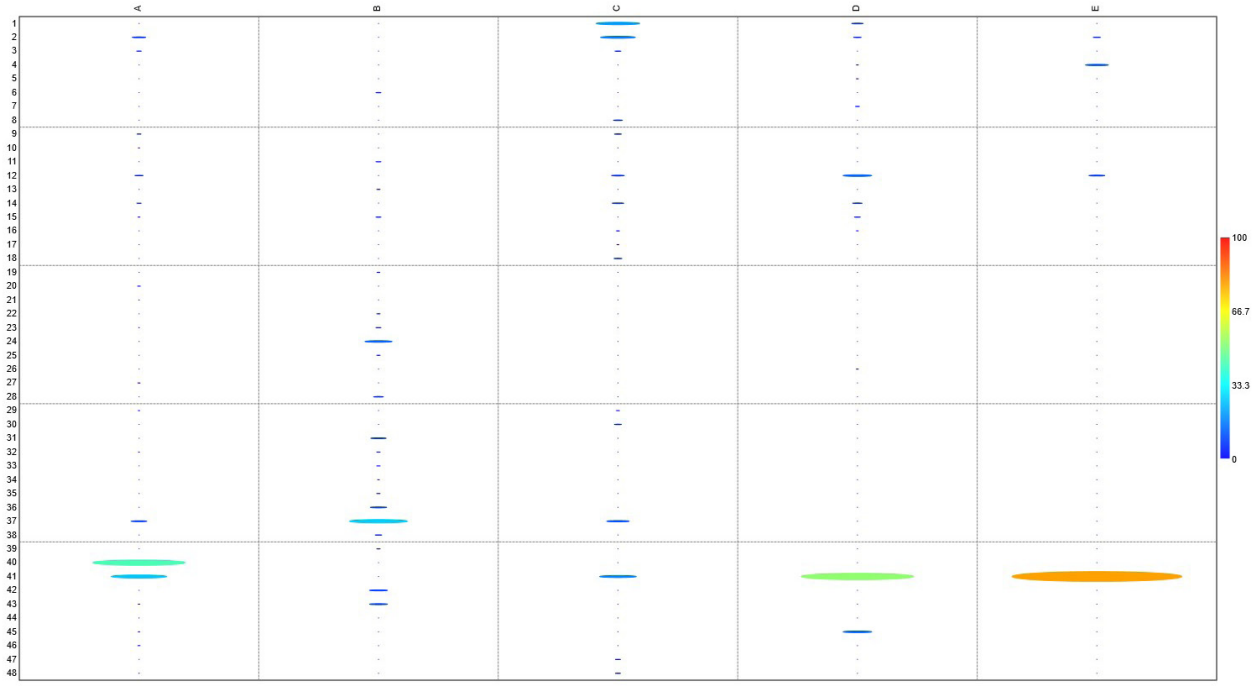

Fig. 4. Diagram of indicator bird species analysis showing the most important indicator species in the habitats of Soldatske village and its surroundings: A-household plots; B-pine forest; C-Vorsklytsia River; D-pastures; and E-agrocenoses.

The ecological conditions of five habitats in Soldatske village and its surroundings in the Okhtyrka district of the Sumy region reflect well the diversity indices Passeriformes (Table 2).

The cluster analysis of the studied habitats according to the biotic diversity indices showed that birds found in household plots and near the Vorsklytsia River formed a separate cluster. This indicates a rather similar species composition of birds (distance 0.8). The second cluster, close in distance, was formed by birds found in pine forests and pastures (distance 2.3). Together with the first cluster, they form the third cluster (distance 4.4), which is joined by the fourth cluster – agrocenoses (distance 8.4). The remoteness of the latter cluster (bird species found in agrocenoses) is probably due to the heterogeneity of soil and vegetation cover (Fig. 3).

Based on the relationship between the index, the value of the indicator, IndVal (De Caceres, Legendre, 2009), and habitat types, it is possible to identify indicator species of habitats in Soldatske village and its surroundings (Fig. 4).

The analysis of indicator species showed separation between different habitats, as evidenced by high indicator values for several species. In agrocenoses, three species had the highest indicative value: *Passer montanus* (78.9), *Galerida cristata* (10.6), and *Sturnus vulgaris* (7.3); in the pastures: *Passer montanus* (52.2); in the household plots: 3 species, *P. domesticus* (42.7), *P. montanus* (25.7), and *Parus major* (7.2); and in the pine forest: 2 species, *Ficedula albicollis* (12.6) and *Parus major* (27.0).The lowest *p*-value of the indicator is near the Vorsklytsia River, *Riparia riparia* (20.3). *Passer montanus* was an indicator species in four habitats, except for the pine forest.

The military operations taking place in Sumy Oblast are the main threat to the biodiversity of Soldatske village and its surroundings. Undoubtedly, the consequences of these threats can be reflected in a decrease in numbers, phenological changes, and changes in trophic interactions. However, given their properties and ability to adapt, I assume that birds of the passerine order may respond differently to these environmental changes.

Assessment of bird distribution by migration status

It is known that bird migration is one of the forms of adaptation to climate seasonality, which allows birds to have a higher number than in a sedentary lifestyle and to use territories for nesting that are favorable in one season and unfavorable in other seasons (Rappole, 2013). So far, the reasons for the existence of the

main migration routes (Baltic–Mediterranean, Polissya latitudinal, Dnipro, and Azov-Black Sea) have been identified and clarified on the territory of Ukraine (Mykytyuk, 1999). According to other literature data, four main flyways (Northwest, Bessarabian, Crimean, and Primorsky) are formed in spring on the territory of Ukraine (Hryshchenko, 1994). According to the results of long-term studies (visual and radar observations and ringing), it was found that birds migrate in the latitudinal direction throughout Ukraine, but two zones are distinguished where the intensity of these movements is much higher: the most populated coastal zone (Azov–Black Sea latitudinal migration route) and Polissya with the northern part of the Forest-steppe (Polissya latitudinal migration route) (Poluda, 2009; Sevastyanov, 1992).

Given the large number of species found in different habitats during the spring, it is important to categorize them by migration status, since two important migratory routes of migratory birds pass through Soldatske village: the broad-frontal meridian and Polissia north-latitude (Fig. 5).

The basis of the Passeriformes population of Soldatske village and its environs is formed by sedentary birds. The highest proportion of sedentary species was found in household plots (31.3%) and in the pine forest (31.3%). The number of birds near the Vorsklytsia River (15.6%) and in the pastures (15.6%) did not differ, but agrocenoses accounted for 6.3%. The group of nesting/migratory birds was most common near the Vorsklytsia River (33.3%) and somewhat less so in the household plots (26.6%). A small proportion of nesting/migratory birds were found in pastures (16.6%) and a small proportion in agrocenoses (3.3%). The share of nesting/migratory/wintering birds was insignificant: 28.6% in pastures and 14.3% in agrocenoses. The group of nesting/migratory/rarely wintering birds had the lowest value among the others: 40% in household plots and 40% in the pine forest, and fewer birds were found near the Vorsklytsia River (20%). No representatives of this group were found in pastures or agrocenoses.

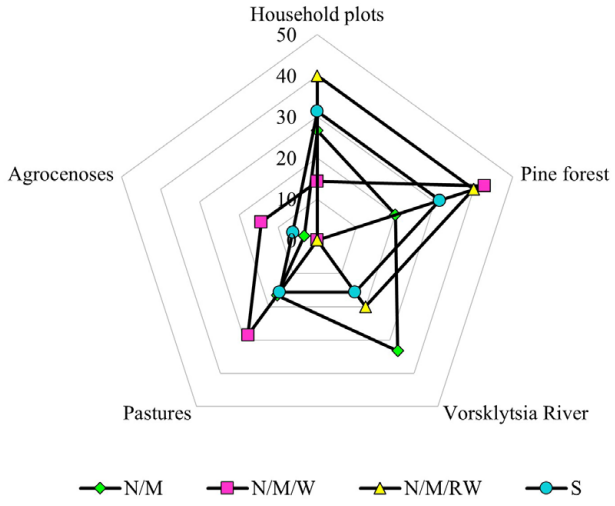

Fig. 5. Distribution of Passeriformes by migration status.

Assessment of bird distribution by ecological group

The structure of the studied biotopes allows us to form ecological groups of birds, which are a corrective tool for studying the state of the ecosystem, reflecting both the potential and real nature of changes occurring under the influence of anthropogenic factors (Fig. 6). Dendrophiles were the most numerous group: in the pine forest (95.2%) (from all species), household plots (66.7%), pastures (50%), and Vorsklytsia River (37.5%). In agrocenoses, the maximum proportion of species (50%) was accounted for by sclerophytes. The campophyll group was found in pastures (33%) and limnophylls (25%) near the Vorsklytsia River.

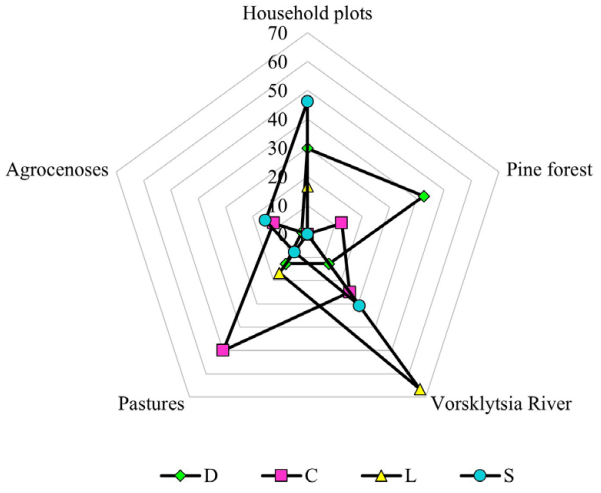

Fig. 6. Distribution of Passeriformes by ecological group.

Assessment of bird distribution by nesting type

The nesting birds of the Passeriformes are the nucleus of the fauna; they are crucial for the formation of local biocenoses, and their nesting is a confirmation of the existence of a stable ecological connection of a species with a particular territory. According to Storch et al. (2023), the full range of properties that characterize a population and ensure its functional unity is manifested only in the breeding territory. Generalized data on the distribution of birds by nesting type are shown in Fig. 7.

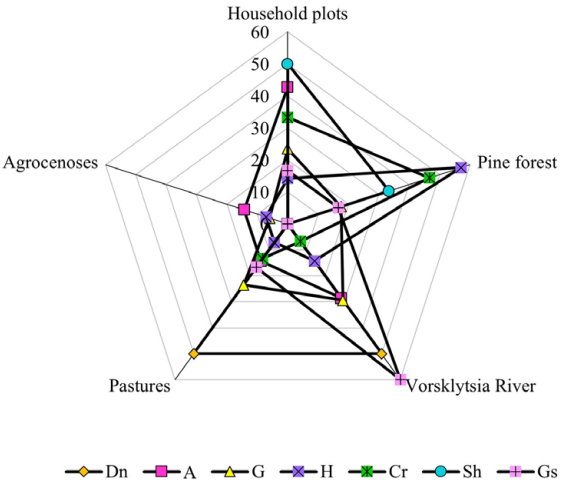

Fig. 7. Distribution of Passeriformes by nesting type.

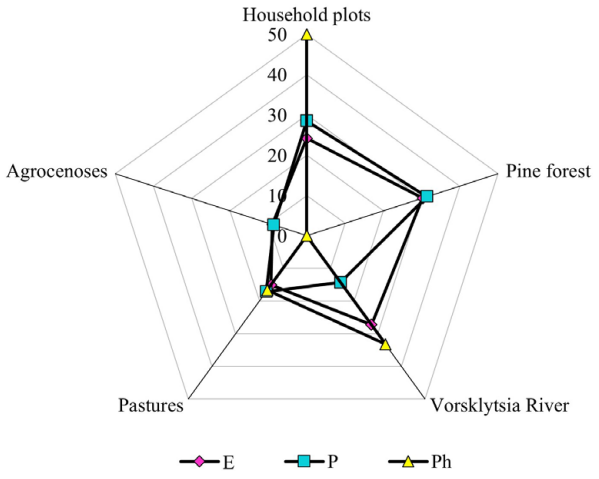

Fig. 8. Distribution of Passeriformes by type of food.

The highest proportion of burrowing birds was found near the Vorsklytsia River (50% of all habitats studied) and pasture (50%). In the household plots, the share of nesting species in anthropogenic structures was 42.8%, while the share of ground-nesting species was 29.4%. Hollow-nesting species had a high proportion (57.1%) in the pine forest, crown-nesting species (46.7%) also in the pine forest, shrub-nesting species (50%) in household plots, and ground-nesting species (60%) near the Vorsklytsia River.

Assessment of the distribution of birds by type of food

In order to objectively assess the status of Passeriformes avifauna, a clear picture of the system of its trophic relationships with habitats was formed. According to the type of food dominating in the diet, all detected birds of Passeriformes were grouped into three subcategories (Fig. 8).

The highest proportion of species was found for entomophagous birds (30.3%) and polyphagous birds (31.4%) in the pine forest, while the group of phytophagous birds had the highest proportion of 50% in household plots. In general, polyphagous birds have a clear advantage over other subcategories, due to their wide trophic spectrum. They are able to use not only different food objects, but also switch to food of anthropogenic origin. Hansson et al. (2010) noted in their work that changes in the feeding diet can affect not only the feeding ecology of specific bird species but also the species composition of the avifauna.

Naturally, such a classification is rather arbitrary, since the diet of most birds varies significantly over the seasons.

Conclusion

From the results, we can conclude that the frontline area of Soldatske village and its surroundings in the Okhtyrka district of the Sumy region supports a sufficient number of birds, which indicates the richness of the overall biodiversity of the region (p<0.05). The richest habitats in terms of the number of species are forests (21) and household plots (21). The lowest species diversity is characterized by the Vorsklytsia River (16), pastures (12), and agrocenoses (4).

Birds of the Passeriformes serve as indicators for the studied habitats, as well as the pressure (impact) they face on the way of migration, at nesting sites, and in search of adequate food resources during military operations.

The presence of both resident and migratory bird species with different seasonal flight distances among birds determines the prospects for using representatives of trivial mass species in the impact monitoring of environmental pollutants at the local and regional levels.

The assessment of bird study by nesting type showed that the highest number of hollow-nesting bird species was found in the pine forest (57.1%). This can be explained both by the generally dominant position of dendrophilous species in the avifauna of the frontline area of Soldatske village and its environs and by the wide ecological plasticity of many of them, despite the military actions.

The studied ecological groups of birds, due to their wide range of food, are important components of trophic chains, and, therefore, their representatives can be used as objects for long-term monitoring of the state of the environment.

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