Impact of climate change on the fauna of passerines (Passeriformes) in urbanized ecosystems of southern Kyrgyzstan

Abstract. The article examines the impact of climate change on the fauna of passerines (Passeriformes) in the urbanized ecosystems of southern Kyrgyzstan. The study was carried out using the method of line transects (route censuses). In the urbanized ecosystems of southern Kyrgyzstan, 84 species of passerines belonging to 19 families and 34 genera have been identified. According to the nature of their stay, there are 29 nestling, 9 wintering, 9 transient, 1 vagrant, and 36 sedentary species. The transition of bird species into the category of “sedentary” was established: previously considered a migrant species - the yellow wagtail (Motacilla flava) and nestling - the common starling (Sturnus vulgaris), blue-headed (Motacilla citreola) and masked wagtail (Motacilla personata). An analysis of the distribution of birds by biotopes, their population density, quantitative indicators by season and the nature of their stay was carried out. The avifaunal formation of urban ecosystems mainly occurs due to birds inhabiting natural and transformed biotopes in the urban surroundings. It has been proven that the formation of avifauna depends on the nature of the presence of birds, seasonal migrations, the abundance and nature of food, the availability of nesting sites, and “disturbance factors.” Their adaptation is directly related to the species of birds arriving from agricultural areas, hilly, steppe biotopes, sylvicolous and petricol landscapes. According to ecological groups, 16 species of birds belong to urbophiles, and 21 species belong to urbophobes.

1 Introduction

In recent years, there has been a high concentration of population in urban ecosystems in the biosphere, which are expanding significantly in terms of both population and area. Consequently, the urban ecosystem is completely special, evolutionarily new for any type of zoocenoses, since all of them arose long before the appearance of various urban complexes on the planet. A feature of the urban ecosystem is its biotopic structure. *Corresponding author: kutman_s@mail.ru*
Ecotones - transitional, intermediate zones between natural landscapes related to ecotonal ecology, the concept of which is still being formed [1, 2].

The construction of cities occupies and urbanizes marginal forest, field and steppe biotopes, and thus disrupts animal communities. Zoocenoses that enter the new environment of urban complexes respond to environmental interference in two ways. Some species move into adequate biotopes past urban complexes directly during the construction of cities or some time after its completion. Others adapt to the urban environment: they choose for themselves an urban biotope that best meets their topical requirements.

The planned changes in zoocenoses, the method and degree of adaptation of certain animal species to the new environment and to humans, the bioindicative, economic, and health significance of animals, all of this forms the basis for zoological research in urbanized complexes. In the same way, the revitalization of cities with animals attractive to the urban population is studied, and, on the other hand, the importance of the urban environment for the conservation of certain species of animals, such as sylvan and petricol species.

Birds are the most diverse group of terrestrial vertebrates in terms of species diversity. In this regard, they occupy a significant place in urbanized ecosystems. By feeding on insects and rodents that cause damage to agriculture and forestry, they help control their population. Along with this, participating in the biological cycle of substances, energy transformation, and maintaining ecological balance, they perform the functions of edificators that shape the environment of urbanized ecosystems.

The bioecological features, species composition and distribution of passerines across urbanized landscapes have been studied by many researchers [3, 4, 5, 6]. According to Yu. Kh. Chon et al., the population density of passerine birds is a crucial factor in habitat utilization [7]. In the conditions of Belarus, using the example of the city of Grodno, the species diversity of the order of passerines (Passeriformes) in urban areas in different seasons of the year was revealed [8].

Due to the fact that zoological research of urbanized complexes is taking first place throughout the world. The study of passerines by species composition, their distribution across biotopes, numbers, the nature of their presence and avifaunal formation in urbanized ecosystems of southern Kyrgyzstan determine the relevance of the research conducted.

2 Materials and Methods

Urbanized ecosystems of southern Kyrgyzstan - the cities of Osh, Jalal-Abad, Kyzyl-Kiya, Tash-Kumyr, etc., are located in the Fergana Valley in the foothills of the Chatkal, Fergana, Alay, Turkestan mountain ranges, which are part of the Turan province, and are located at an altitude of 585–1,110 m above sea level. The landscape type is semi-desert, dry subtropical. Climatic features: the average temperature in January is -3–8°C, in July +24–30.5°C, the level of annual precipitation is 30–468 mm. The cities are surrounded by hills, steppes, and agricultural lands.

The internal structure of urbanized ecosystems, soil, climate, anthropogenic noxes, plants and other biotopes, consists of zoocenoses corresponding in their biotope characteristics. Their internal structure consists of a central part (multi-storey buildings, one-two-storey houses, parks, squares, green fences along roads, ecotones along the banks of rivers, canals); garbage dumps; agricultural areas; hilly-steppe areas and mosaic habitat environment.

The research was conducted in the cities of Osh, Jalal-Abad, Tash-Kumyr, and Kyzyl-Kiya. The research sites were chosen based on their similar physiogeographical characteristics and biotope structures. Having classified similar systems according to their internal structure, we identified 7 biotopes within the boundaries of these cities (Table 1).
Table 1. Structure of biotopes of urbanized ecosystems

<table>
<thead>
<tr>
<th>No.</th>
<th>Biotopes</th>
<th>Description</th>
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| 1   | Multistory residential buildings (M.R.B.) | Multistory buildings. Artificial ground cover (asphalt, concrete) - 60-80%.
| 2   | One or two-story houses (O.T.S.H.)        | One- or two-story houses built on the outskirts of the city and their rural and livestock complexes. Artificial ground cover (asphalt, concrete) - 40-60%.
| 3   | Green zones (G.Z.)         | Parks, squares, alleys and perennial trees. Artificial ground cover (asphalt, concrete) - 5-10%.
| 4   | Recreational zones (R.Z.)  | Urban water pools, recreational areas, and resort zones. Coastal ecosystems: Ak-Buura, Kok-Art, Naryn, Isfayram-Say rivers. |
| 5   | Landfill sites (L.S.)      | Urban garbage dumps and waste disposal sites within the city. In this biotope, there is little "disturbance factor" for zoocenoses. |
| 6   | Agricultural land (A.L.)   | Fields for growing industrial crops around the city.                        |
| 7   | Hills, steppes (H.S.)      | Hills, wastelands, altered steppes, grazing areas and hayfields, cemeteries, various quarries, etc., surrounding the city. |

The study of passerines was carried out comprehensively (species composition, distribution by biotopes, abundance, seasonal distribution, nature of stay, features of fauna formation) using the method of line transects, where route censuses were used to determine quantitative indicators on 7 stationary biotopes. The distance between transects was 4-9 km, and the width of the route was 100 m (50 m each on the left and right). The methods of determination [9, 10, 11] were used to determine the species composition. The headcount was conducted visually and aurally. Statistical calculations were carried out using the "Statist" and "Statistical Processing" programs.

The research materials were collected by the authors from 2019 to 2023 during 22 expeditions and 510 hiking routes with a total length of 1,806 km. During the census period, 158,953 bird individuals belonging to 84 passerine species were counted. Laboratory and cameral processing of the collected material was carried out at the Department of Zoology, Ecology and Bioengineering of Osh State University.

3 Results and Discussions

The process of urbanization invariably leads to dramatic changes in former natural ecosystems. In order to address these issues, we have chosen the widespread passerines (Passeriformes) as the subject of our research, as they are considered the most biologically diverse. Of all bird species known in the biosphere (about 9 thousand), passerines account for 63% (5,120 species). In Kyrgyzstan, 391 species of birds are found, of which passerines make up 183 species (46.9%), and 84 (45.9%) species of these birds are found...
According to our data, in 7 biotopes, the dominant position in terms of quantity is occupied by the tree sparrow (*Passer montanus* (Linnaeus, 1758)) - 28.26%, and the subdominant is the myna (*Acridotheres tristis* (Linnaeus, 1766)) - 18.47%. Background species are: common starling (*Sturnus vulgaris* Linnaeus, 1758) - 7.07%, jackdaw (*Pyrrhocorax graculus* (Linnaeus, 1766)) - 4.44%, rook (*Corvus frugilegus* Linnaeus, 1758) - 4.03%, magpie (*Pica pica* (Linnaeus, 1758)) - 2.52%, house sparrow (*Passer domesticus* (Linnaeus, 1758)) - 2.32%, Spanish sparrow (*Passer hispaniolensis* (Temminck, 1820)) - 2.01% and blackbird (*Turdus merula* Linnaeus, 1758) - 1.71%.

Distribution of passerines by biotopes

− Biotope of multi-storey buildings. This area is called the central part of the city or the “asphalt” area. As a result of the research, 61 species of passerines were recorded, of which the tree sparrow is dominant (46.64%), myna is subdominant (16.34%). Passerines of this biotope make up 33.3% of all passerine birds in Kyrgyzstan, and their share in the urbanized areas we studied was 72.6%.

− Biotope of one- and two-story houses. 77 species (91.7%) of passerines have been identified here. The tree sparrow is dominant (35.88%), the myna is subdominant (17.79%).

− Biotope of green zones. 69 species (82.14%) were registered in this biotope, where the dominant position is occupied by the tree sparrow (24.04%), the subdominant position is occupied by the myna (17.6%).

− Biotope of recreational zones. Due to the fact that this biotope is a natural or semi-anthropogenic biocenosis, passerines have the richest species diversity here - 79 species, where the tree sparrow is the dominant (19.57%) and the myna is the subdominant (16.75%).

− Biotope of garbage dumps. 37 species are identified here. The dominant is the myna (24.94%), the subdominants are the tree sparrow (18.73%) and the common starling (18.42%).

− Biotope of agricultural territory. 71 species are recorded here, of which the dominant is the tree sparrow (35.67%), and the subdominant is the myna (13.68%).

− Biotope of hilly, steppe territories. 50 species have been identified, where the dominant is the myna (13.47%), subdominants: snow finch (7.43%), hoodie (6.79%), jackdaw (6.65%) and crested lark (5.99%).

Features of population density by biotopes (individuals/km²). This section provides data on passerine population density by biotopes. Thus, 26 species out of 84 are found in all biotopes of the urbanized ecosystem, which indicates the complete adaptation of these species to the environment and conditions of the urbanized ecosystem. However, according to the nature of their stay, they belong to different categories. The tree sparrow and myna have the highest population density in all biotopes. Accordingly, their density ranges from 12.41±1.27 to 279.88±1.72 and from 16.34±0.24 to 144.9±1.79 individuals per 1 km². The two dominant species in terms of population density show the suitability of the ecological niche of the urbanized ecosystem for nesting and reproduction.

The most convenient biotopes for passerines are recreational areas and areas of one- or two-story houses.

Seasonal distribution and population density (individuals/km²). As the seasons change, passerines migrate from one territory to another. Some birds arrive in the winter (wintering), others arrive in the spring-summer time for nesting (nestling), and the third type of birds live year-round (sedentary). This section provides the species composition by season and population density of passerine birds in different biotopes of urbanized ecosystems.

− Biotope of multi-storey buildings. Of the identified 61 species, the following are found here: in winter - 32 (38.1%), in spring - 49 (58.3%), in summer - 45 (53.6%) and in...
In winter, the dominant position is occupied by the tree sparrow (106.33±2.18 individuals); subdominant position - myna 92.0±1.46 individuals. Along with this, the population density of passerines in winter was 45.00±1.06 for the common starling (7.42%), 32.17±0.91 for the house sparrow (5.3%), and 24.33±0.80 individuals for the rook (4.01%).

In spring, the density of the dominant species, the tree sparrow, is 146.8 ± 1.58 individuals, and the subdominant species, the myna, is 133.0 ± 1.5 individuals.

In summer, the density of the dominant species, the tree sparrow, is 57.63±2.38 individuals, and the subdominant species, the myna, is 71.13±1.85 individuals.

In autumn, the density of the dominant species, the tree sparrow, is 137.8±2.6 individuals, and the subdominant species, the myna, is 65.0±2.10 individuals.

Fig. 1. Distribution of bird species by seasons of the year in the biotope of multi-storey buildings - Biotope of one- and two-story houses. Here are 77 species, of which 32 (38.1%) are found in winter, 53 (63.1%) in spring, 54 (64.3%) in summer, and 44 (52.4%) in autumn. There are 17 sedentary species.

In winter, the dominant is the tree sparrow - 262.6 ± 2.19 individuals, the subdominant is the myna - 78.9 ± 1.57 individuals.

In spring, the dominant is the tree sparrow - 386.8±1.78 individuals, the subdominant is the mynah - 157.5±1.42 individuals.

In summer, the dominant is the tree sparrow - 224.9±1.57 individuals, the subdominant is the myna - 132.8±1.29 individuals.

In autumn, the dominant is the tree sparrow - 147.7±2.54 individuals, the subdominant is the myna - 69.6±2.03 individuals.

Fig. 2. Distribution of bird species by seasons of the year in the biotope of recreational zones. Only 79 species are registered here. Of these, 32 (38.1%) species are found in winter, 66 (78.6%) species in spring and summer, and 62 (73.8%) species in autumn. 21 species are sedentary. The dominant species in winter is the tree sparrow (133.53±3.07), the subdominant species is the myna (40.1±2.20 individuals).

In spring, the dominant is the tree sparrow - 81.08±2.56 individuals, the subdominant is the myna - 52.2±1.2 individuals.

In summer, the dominant is the tree sparrow - 69.25±2.23, the subdominant is the myna - 54.6±2.03 individuals.

In autumn, the dominant is the myna - 37.67±3.02, the subdominant is the tree sparrow - 28.50±2.71 individuals.
Fig. 2. Distribution of bird species by season in the biotope of recreational zones − Biotope garbage dumps. 8 out of 37 species are found at all times of the year. Despite the fact that the species composition is smaller than in other biotopes, the number is much higher, since the food supply here is richer. The numerical distribution of species is as follows: in winter - 15 (17.9%), in spring - 30 (35.7%), in summer - 22 (26.2%), and in autumn - 16 (19.1%) species.

In winter, the dominant species is the myna (326.08±1.23), the subdominant ones are the common starling (267.1±1.15) and the tree sparrow (267.3±1.15).

In spring, the dominant species is the myna - 115.13±2.20, the subdominant one is the tree sparrow - 85.13±1.99 individuals.

In summer, the dominant species is the myna - 26.63±3.50, the subdominant ones are the tree sparrow - 22.44±3.28, and the house sparrow - 21.69±3.23 individuals.

In autumn, the dominant species is the Spanish sparrow (169.50±1.17), the subdominant ones are the myna (137.67±1.65) and the starling (126.67±1.60 individuals).

Fig. 3. Distribution of bird species by season in the biotope of hilly and steppe territories − The biotope of agricultural territories includes 71 species. In winter, 31 species, the dominant one is the tree sparrow (117.65 ± 2.54), the subdominant ones are the jackdaw (43.8 ± 1.8) and the myna (38.68 ± 1.69 individuals.)

In spring, the dominant species is the tree sparrow - 93.3±2.53, the subdominant ones are the starling - 42.25±0.89, and the myna - 39.50±1.83 individuals.

In summer, the dominant species is the tree sparrow - 160.13±2.23, the subdominant one is the myna - 56.0±1.53 individuals.

In autumn, the dominant species is the tree sparrow - 94.83±3.02, the subdominant one is the myna - 61.17±2.67 individuals.

- Biotope of hilly, steppe territories. 50 species were registered, of which: in winter - 30 (35.7%), in spring and autumn - 32 (38.1%), in summer - 27 (32.1%) species (Fig. 3).

In winter, the dominant one is the snow finch - 63.85±2.34, the subdominant one is the hoodie - 43.08±2.01 individuals.

In spring, the dominant species is myna - 52.06±2.24, the subdominant ones are the crow - 24.7±1.63 and the jackdaw - 21.76±1.54 individuals.

In summer, the dominant species is the myna - 42.63±2.37, the subdominant one is the house sparrow - 31.4±2.09 individuals.

In autumn, the dominant species are the jackdaw - 29.46±2.0, the myna - 29.46±2.0, the rook - 27.14±1.93 and the crested lark - 23.39±1.81;
The subdominant ones are the common starling - 17.50±1.59, the tree sparrow - 16.25±1.53 and the hoodie - 14.46±1.45 individuals.

The nature of stay of passerines. In science, there are the following categories of birds: nestling (B); wintering (W); transient or migrants (M); vagrants, or visitors (V) and sedentary (BW). Nestling species are the species that arrive in specific habitats in the spring and summer, build nests, raise their young, reproduce, and then fly away again in the autumn; wintering species are the species that are only present in the winter; transient species are the birds that pass through specific habitats; vagrants are the species that arrive in habitats by chance and quickly fly away; sedentary species are those that inhabit specific habitats throughout the year [12, 13]. Based on the collected materials, it is examined through which categories of distribution the formation of the avifauna of passerines occurs (Table 2).

In the course of research, it was established that those species of birds belonging to the category of "nestling" ("B") are found in winter and replenish the category of "sedentary" ones ("BW"). They include: masked wagtail (Motacilla personata Gould, 1885) 2020, 2021, 2022, 2023, in all biotopes; yellow wagtail (Motacilla flava Linnaeus, 1758) 2019, 2021, 2023, in biotopes of one- or two-story houses, green and recreational zones, agricultural, hilly and steppe areas; yellow-headed wagtail (Motacilla citreola Pallas, 1776) 2019, 2020, 2022, in biotopes of multi-storey buildings and recreational zones; common starling (Sturnus vulgaris Linnaeus, 1758) in all biotopes. At the same time, it has been proven that the rook (Corvus frugilegus Linnaeus, 1758) as a "sedentary" ("BW") species is found in the urban ecosystem only in winter and early spring, which indicates its transition to the "wintering" ("W") category.

Summarizing the data obtained, it should be noted that out of 84 species of passerines found in various habitats of the urban ecosystem, 29 species belong to the category of "nestling", 9 are "wintering", 9 are "transient", 1 is "vagrant", and 36 are "sedentary" (Fig. 4).

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<tr>
<td>19</td>
<td>Buntings (Emberizidae)</td>
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Table 2. Categories of stay of passerines in urbanized ecosystems

E3S Web of Conferences 537, 05020 (2024)  
SDEA-2024

https://doi.org/10.1051/e3sconf/202453705020
Fig. 4. The nature of stay and the number of species of passerine birds in urbanized ecosystems: “B” – nestling; “W” – wintering; “M” – transient; “V” – vagrant; “BW” – sedentary.

Nestling species. It was established that in the biotopes of the urban ecosystem, 29 (34.5%) species belong to the category of “nestling”. As shown in Table 2, the species of birds in this category have relatively high numbers compared to other categories. Basically, this category is formed by representatives of nestling and sedentary species.

Wintering species. In the biotopes of the urban ecosystem, “wintering” passerines account for 9 species (10.7%) and are replenished by birds that arrive in late autumn. They include: rook (Corvus frugilegus), hoodie (Corvus cornix), robin (Erythacus rubecula), black-throated blackbird (Turdus atrogularis), chaffinch (Fringilla coelebs), finch (Fringilla montifringilla), siskin (Spinus spinus), goldfinch (Carduelis carduelis) and common bunting (Emberiza citrinella). “Wintering” birds arrive in urban ecosystems for the winter in October and fly away in March. This research analyzed the species composition and population density of passerine birds in spring and autumn.

Transient species. 9 species (10.7%) of passerines have been recorded as migrants in various biotopes. This category includes: steppe lark (Melanocorypha calandra), yellow wagtail (Motacilla flava), red-backed shrike (Lanius collurio), alpine jackdaw (Pyrrhocorax graculus), willow warbler (Phylloscopus trochilus), chiffchaff (Phylloscopus collybita), yellow-browed warbler (Phylloscopus inornatus), common redstart (Phoenicurus phoenicurus) and garden bunting (Emberiza hortulana).

Vagrants. In the biotopes of the urban ecosystem, only one species of this category is found – the rustic bunting (Emberiza rustica), which was registered during the census in 2019, 2020, 2022, 2023. If we look at the biotopes, this species is observed in the area of multi-storey buildings and green zones in spring, in the biotope of recreational zones in winter, spring and summer, and in hilly, steppe territories in winter.

Sedentary species. This category includes 36 species from 14 families.

Formation of the passerine fauna. Previously, urban areas were natural landscapes. As a result of urbanization processes, urban ecosystems and different biotopes were formed [14, 15]. The formation of the passerine fauna in the urban ecosystem occurs in the same way as in natural ecosystems and is directly related to various categories of stay and ecological groups of birds: urbophiles, dendrophiles, sclerophiles, limnophiles, campophiles. In other words, the avifauna is created by representatives of these groups.

In the studied biotopes of urbanized ecosystems, the species composition and abundance have the following indicators: multi-storey buildings – 61 species, total number of recorded individuals – 24,374; one-two-storey houses – 77 species, individuals – 32,890; green zones – 69 species, individuals – 12,764; recreational zones – 79 species, individuals – 21,137; garbage dumps – 37 species, individuals – 41,528; agricultural territories – 71 species (2024).
species, individuals - 15,367; and hilly, steppe territories - 10,893

Fig. 5. The number of species of passerine birds (Passeriformes) by biotopes

Fig. 6. Absolute number of passerine birds (Passeriformes) by biotopes

In 5 out of 7 biotopes, the tree sparrow (Passer montanus) is dominant (multi-story buildings, one-two story houses, green zones, recreational and agricultural areas), and in one biotope (garbage dumps) it is subdominant. Myna (Acridotheres tristis) is dominant in 2 biotopes - garbage dumps and hilly, steppe areas. In 4 biotopes (one-and two-story houses, green and recreational zones) it occupies a subdominant position.

The common starling (Sturnus vulgaris) is subdominant in the biotopes of multi-storey buildings and garbage dumps, the snow finch (Montifringilla nivalis) is subdominant in hilly, steppe areas. Background species by biotopes have the following indicators: multi-storey buildings - 10 species, one-two story houses - 16, green and recreational zones - 20 each, garbage dumps - 9, agricultural territories - 16 and hilly, steppe territories - 18.

When dividing the birds found in the urban ecosystem into ecological groups, it turned out that out of 84 species living in urban ecosystems, 16 are urbophiles and 21 are urbophobs. The remaining 47 passerine species belong to different ecological groups (Table 3).

Table 3. Ecological groups of passerines

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<td>Snow finch (Montifringilla nivalis)</td>
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Table 3. Ecological groups of passerines
2. Red-rumped swallow (Hirundo daurica)
3. Turkestan shrike (Lanius phoenicuroides)
4. City swallow (Delichon urbica)
5. Black-headed shrike (Lanius schach)
6. Yellow wagtail (Motacilla flava)
7. Lesser gray shrike (Lanius minor)
8. Yellow-headed wagtail (Motacilla citreola)
9. Golden oriole (Oriolus oriolus)
10. Masked wagtail (Motacilla personata)
11. Magpie (Pica pica)
12. Common starling (Sturnus vulgaris)
13. Raven (Corvus corax)
14. Rose-colored starling (Sturnus roseus)
15. Wren (Troglodytes troglodytes)
16. Myna (Acridotheres tristis)
17. Southern nightingale (Luscinia megarhynchos)
18. Jackdaw (Corvus monedula)
19. Rufous-necked tit (Parus rufonuchalis)
20. Rook (Corvus frugilegus)
21. Azure tit (Parus cyanus)
22. Hoodie (Corvus cornix)
23. Yellow-breasted tit (Parus flavipectus)
24. Blackbird (Turdus merula)
25. Turkestan tit (Parus bokharensis)
26. House sparrow (Passer domesticus)
27. Wallcreeper (Tichodroma muraria)
28. Tree Sparrow (Passer montanus)
29. Indian sparrow (Passer indicus)
30. Finch (Fringilla coelebs)
31. Spanish sparrow (Passer hispaniolensis)
32. Rock sparrow (Petronia petronia)
33. Finch (Fringilla montifringilla)
34. Siskin (Spinus spinus)
35. Grey-headed goldfinch (Carduelis caniceps)
36. Corn-bunting (Emberiza calandra)
37. Of the passerines found in urbanized ecosystems, 19.04% were urbophiles, 25.0% were urbophobes. The remaining species are included in the ecological groups: dendrophiles, sclerophiles, limnophiles, campophiles.

4 Conclusions

In the urbanized ecosystems of southern Kyrgyzstan, 84 species of passerines belonging to 19 families and 34 genera have been identified. According to the nature of their stay, there are 29 nestling, 9 wintering, 9 transient, 1 vagrant, and 36 sedentary species. In terms of population density in the biotopes of multi-storey buildings, one- and two-storey houses, green zones, recreational and agricultural areas, the dominant species is the tree sparrow (Passer montanus), the subdominant species is the myna (Acridotheres tristis). In the biotopes of garbage and hilly, steppe territories, the dominant species is the myna (Acridotheres tristis), the subdominant species are the common starling (Sturnus vulgaris), the tree sparrow (Passer montanus), the crested lark (Galerida cristata), the jackdaw (Corvus monedula), and the snow finch (Montifringilla nivalis).
In terms of the number of individuals, the highest figures (303.4±1.19; 1,267.5±1.74 individuals/km²) were found in the biotopes of garbage dumps and hilly, steppe territories. It should be noted that the highest species diversity indicators by season were observed in recreational areas: 32 in winter, 66 in spring and summer, and 62 in autumn.

It was found that in all studied biotopes, the tree sparrow (Passer montanus) and the myna (Acridotheres tristis) have the highest population density (279.88±1.72 and 144.9±1.79 individuals/km², respectively).

It has been proven that the formation of avifauna depends on the nature of the presence of birds, seasonal migrations, the abundance and nature of food, the availability of nesting sites, and “disturbance factors.” Their adaptation is directly related to the species of birds arriving from agricultural areas, hilly, steppe biotopes, sylvan and petricol landscapes.

According to ecological groups, 16 species of birds belong to urbophiles, and 21 species belong to urbophobes.

References
14. V.E. Flint, Regularities of formation of the avifauna of urban forest parks. Ornithology, 12, 41-58 (1976)