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ZOOLOGY

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## Classification of Birds of the Pre-Altai Plain according to Similarities of the Summer Distribution

A. V. Makarov<sup>a, \*</sup>, E. A. Belikova<sup>b</sup>, E. N. Bochkareva<sup>a</sup>, and Z. M. Sergazinova<sup>c</sup>

<sup>a</sup> Institute of Systematics and Ecology of Animals, Siberian Branch, Russian Academy of Sciences, Novosibirsk, 630091 Russia

<sup>b</sup> Altai College of Industrial Technology and Business, Biisk, 659321 Russia

<sup>c</sup> Toraigyrov Pavlodar State University, Pavlodar, 140008 Kazakhstan

\*e-mail: [al\\_micromammals@mail.ru](mailto:al_micromammals@mail.ru)

Received September 11, 2020; revised February 3, 2021; accepted February 3, 2021

**Abstract**—The results of routing counts of birds on the territory of the Pre-Altai Plain in the summer periods of 2003–2005 and 2014–2016 are analyzed. A total of 42 bird population options were used. Based on factor analysis, classification hierarchical schemes were compiled on the distribution of birds separately for the first and second half of summer. It has been shown that in the first half of summer most bird species prefer forests, open meadow–steppe, and field habitats, as well as floodplains. In the second half of summer, the general character of the distribution of species remains, but the proportion of the forest type of preference is reduced, and the meadow–field type comes out on top. A comparative analysis with similar classifications by the mountain provinces of Altai and the forest–steppe and steppe territories of the south of the West Siberian Plain is carried out.

**Keywords:** ornithocomplex, species classification, similarity in distribution, preference, environmental factors, Pre-Altai Plain

**DOI:** 10.1134/S1062359022030116

### INTRODUCTION

According to the physical-geographical zoning, the Pre-Altai Plain is part of the Altai mountain region as the separate North Pre-Altai province. It borders on the Altai Mountains from the northwest and north with a narrow foothill strip with a total area of ~21 000 km<sup>2</sup>. In the north, the Pre-Altai Plain borders on the orographic units of the southeastern part of the West Siberian Plain: in the northwest on the Ob Plateau and in the northeast on the Bie-Chumysh Upland. From the south, the mountainous provinces of the Northwestern, Northern, and Northeastern Altai adjoin the Pre-Altai Plain, and in the eastern part, it gradually passes into the foothills of the Salair (*Atlas Altaiskogo kraja*, 1978).

The results of bird distribution analysis are presented in the form of idealized hierarchical classifications that reflect the differentiation of species into groups as a variant of ordering and a way to display the resulting representations compactly. Identification of similarities in the nature of stay and distribution of birds was carried out using multivariate factor analysis. Its advantages are that mathematical processing of the material removes a number of difficulties associated with the gradual change in distribution from one group of species to another (Bochkareva et al., 2013). Studies on the quantitative assessment of bird distributions are

presented relatively widely. Some of these publications were devoted to the forest–steppe and steppe of the Tobol-Irtysh and Ob-Irtysh interflaves of Western Siberia (Solovyov, 2005, 2012; Toropov, 2008), as well as the forest–steppe of Central Siberia (Zhukov, 2006). There are studies on the spatial distribution of birds in certain mountainous provinces of Altai (Ravkin, 1984; Tsybulin, 1999; Bochkareva and Irisova, 2009; Toropov and Grazhdan, 2010; Bochkareva, 2011; Bochkareva and Livanov, 2013) and Altai as a whole (Tsybulin, 2009). Such studies have not been carried out before for the Pre-Altai Plain, despite the relatively good knowledge of its territory as regards avifauna. Based on this, the goal of this study is to identify groups of bird species with similar spatial distribution in the first and second halves of summer and to compare the results with border areas.

### MATERIALS AND METHODS

Birds were counted in 2003–2005 and from 2014 to 2016 in four key sites. Of these, the first includes the residential habitats in the city of Biisk, which were surveyed in 2003–2005 (Belikova, 2007). At the second site located in the vicinity of the villages of Usyatskoye and Krasnogorskoye, this work was carried out in 2014 in 11 habitats (Biiskii and Krasnogorskii regions of Altai krai). Published materials on five foothill land-

scape tracts in the vicinity of the village of Nizhnyaya Neninka were also used for this site for 1998 (Toropov and Grazhdan, 2010). The third and fourth key sites were laid in the central and western parts of the Pre-Altai Plain within the Petropavlovskii and Kuryinskii regions of Altai krai. Arid and moderately arid steppe landscapes are most common here, in which a total of 19 habitats were surveyed. In total, taking into account our and borrowed materials, the total amount of data used for the summer period was 42 bird population options, while 175 bird species were counted in the first half of summer and 158 species of birds were counted in the second half.

Bird counts were carried out on permanent, but not strictly fixed routes without limiting the width of the transect. At the same time, each habitat was surveyed for every half a month covering a distance of 5 km and areas along riverbanks were surveyed covering a distance of 10 km. Bird counts estimated the distance to birds at the time of detection (Hayne, 1949), and the recalculation to the area was carried out according to the harmonic average detection range by the interval method (Ravkin, 1967). The total length of the main count routes was ~2000 km. The results of all bird counts, including those on rivers, were reduced to the number of individuals per 1 km<sup>2</sup>.

When compiling the classification of bird species according to the similarity of distribution, the Jaccard coefficient (Jaccard, 1902) for quantitative traits was used as a measure of similarity (Naumov, 1964). The analysis was carried out using a factor classification program (Trofimov, 1976; Trofimov and Ravkin, 1980). This classification combines species according to the maximum similarity into an unspecified number of groups. The results of the first division correspond to the distribution types. The identified groups are further subdivided into subtypes and distribution classes using the same program until the resulting clusters include no more than five species and their distribution can be explained by various environmental factors. If during the first and subsequent divisions the resulting types and subtypes included species that were not typical for certain landscape tracts, then, according to idealized ideas, they were redistributed into groups that were close to them in composition. The species names of birds are given according to the studies by Koblik et al. (2006) and Koblik and Arkhipov (2014). The names of monophyletic species that were not distinguishable during counts and were determined presumably are given in question with an indication in brackets of the group of species to which they belong or belonged earlier as recommended by the International Code of Zoological Nomenclature (2004). In addition, due to the fact that both species of martins (the Common Sand Martin (*Riparia riparia*) and the Pale Sand Martin (*R. diluta*)) are difficult to distinguish during the counts, they were counted together under the common name, the Common Sand Martin (*R. riparia*).

## RESULTS AND DISCUSSION

### *Classification of Bird Species according to the Similarity of Distribution in the First Half of Summer*

According to the results of factor classification, all 175 counted bird species are grouped into three super-types of habitat preference: species of undeveloped and built-up land as well as aquatic and semi-aquatic communities. When using the classification given below, it must be taken into account that the phrase we use ("birds that prefer...") denotes a group of species that have the maximum overlap in zones of preference. The words "in addition" refer to markers up to the end of the sentence (up to a period or up to a semicolon). The enumeration following these words must be considered as additional information for the previous description of the species distribution. For example, the species such as the European Redstart, Great Tit, and Greenfinch that belong to subtype 1.2 and class 1.2.1 equally prefer both birch–pine forests and urban areas and villages.

#### *Birds That Prefer Undeveloped Habitats*

**(1) Forest type preference** (Ural Owl, White-backed Woodpecker, Tree Pipit, Siberian Rubythroat, European Chiffchaff, Common Chaffinch).

Birds that prefer the following:

(1.1) pine forests (Nighthawk, Mistle Thrush, Wood Warbler, Gold-crested Wren, Common Jay, Bramble Finch, Siskin);

(1.2) birch–pine forests (Common Woodcock, Great Grey Owl, Black Woodpecker, Waxwing, Coal Tit, Common Crossbill) and

(1.2.1) urban areas and settlements (European Redstart, Great Tit, Greenfinch);

(1.3) birch forests (Oriental Cuckoo, Red-backed Shrike, Oriole);

(1.4) pine and birch–pine forests (Hazel Grouse, Greater Spotted Woodpecker, Song Thrush, Spotted Flycatcher, European Pied Flycatcher, Icterine Warbler, Willow Tit, Nuthatch);

(1.5) wet birch–aspen forests (Black-throated Thrush, Red-winged Thrush, Rufous-tailed Robin, Orange-flanked Bush Robin, Thick-billed Warbler, Yellow-browed Warbler, Common Treecreeper, Bullfinch) and

(1.5.1) floodplain willow meadows (Lesser Spotted Woodpecker, Fieldfare, Golden Mountain Thrush, Eurasian Long-tailed Tit, Hawfinch).

**(2) Floodplain type of preference** (Hen Harrier)

Birds that prefer the following:

(2.1) willow meadows (Pigeon Hawk, Greater Spotted Eagle, Common Moorhen, Black Coot, European Curlew, Marsh Sandpiper, Needle-tailed Swift, Whinchat, Sedge Warbler, Black-faced Bunting) and

(2.1.1) lowland swamps (Common Crane, Land Rail);

(2.2) shrub meadows (Red-footed Falcon, Goshawk, Water Rail, Common Long-eared Owl, Wryneck, Three-toed Woodpecker and Gray-headed Woodpecker, Black-throated Accentor, Nightingale, Cetti's Warbler, Arctic Warbler, Eurasian Whitethroat, Lesser Whitethroat, Eurasian Goldfinch, Common Rosefinch, Yellow Bunting, and Common Reed Bunting) and

(2.2.1) birch–pine and birch forests (Eastern Turtle Dove);

(2.2.2) settlements (Blyth's Reed Warbler).

**(3) Meadow-field type of preference** (Common Kestrel, European Hobby, Black Kite, Buzzard, Demoiselle Crane)

Birds that prefer the following:

(3.1) meadows alternating with copses (Black Grouse, Honey Buzzard, Sparrow Hawk, Stock Dove, Hoopoe, Blackcap) and

(3.1.1) lowland swamps and floodplain willow meadows (Garden Warbler, Pine Bunting);

(3.2) grazing meadows (Ruddy Shelduck, Saker Falcon, White-tailed Eagle, Steppe Eagle, Imperial Eagle, Golden Eagle, Pacific Swift, Steppe Pipit);

(3.3) fields (Willow Ptarmigan, Quail, Pale Harrier, Common Wood Pigeon, Scops Owl, Sky Lark, Tawny Pipit and Eastern Tree Pipit, Yellow Wagtail, Asian Stonechat? (Stonechat), Eastern Grasshopper Warbler, Booted Warbler, Gray-headed Goldfinch, Eurasian Linnet, Ortolan Bunting, and Red-headed Bunting).

#### **(4) Steppe type of preference**

Birds that prefer feather-grass steppes (Gray Partridge, European Bee Eater, Common Wheatear).

#### **(5) Swamp type of preference**

Birds that prefer lowland swamps (Marsh Harrier, Rail, Marsh Snipe, Common Snipe, Redshank, Wood Sandpiper, Yellow-headed Wagtail, Blue-throated Robin, Pallas's Grasshopper Warbler, Willow Warbler, Dusky Warbler, and Radde's Warbler) and

(5.1) forests (Cuckoo);

(5.2) floodplain shrub meadows (Long-tailed Rosefinch);

(5.3) floodplain willow meadows (Common Pin-tail, Lanceolated Warbler, Yellow-breasted Bunting);

(5.4) meadow-field habitats (Marsh Owl).

#### *Birds That Prefer Built-up Habitats*

**(6) Residential type of preference** (Rock Pigeon, White Wagtail, Gray Crow, House Sparrow and Tree Sparrow).

Birds that prefer the following:

(6.1) settlements (Common Swift, Common Swallow, Jackdaw, Rook, Eastern Carrion Crow? (Carrion Crow), Northern Raven) and

(6.1.1) floodplain shrub meadows (Greenish Warbler, Magpie);

(6.2) areas of urban multistory buildings (Common House Martin).

#### *Birds That Prefer Aquatic and Semi-Aquatic Habitats*

**(7) River type of preference** (European Wigeon, Gadwall, Common Pochard).

Birds that prefer the following:

(7.1) small rivers (Common Teal, Mallard, Garganey, Northern Lapwing, Little Ringer Plover, Gray Gull, Kingfisher, Gray Wagtail) and

(7.1.1) medium rivers (Gray Heron);

(7.1.2) settlements (Masked Wagtail, Starling);

(7.2) medium rivers (Black Stork, Common Pied Oystercatcher, Common Sandpiper, Common Black-headed Gull);

(7.3) large rivers (Whooper Swan, Common Shoveler, Peregrine Falcon, Common Gull, Heuglin's Gull? (Herring Gull), Common Tern, Common Sand Martin).

Thus, in the first half of summer, most birds prefer forest habitats (46 species, 26%), while fewer species prefer meadow-field landscapes (37 species, 22%) and floodplain habitats (32 species, 18%). We found 25 and 18 species that gravitate to rivers and swamps, respectively (14 and 10%), and even fewer species that tend to settlements (14 species, 8%). Only three species (Gray Partridge, European Bee Eater, and Common Wheatear) prefer steppes (2%).

Thus, the distribution of birds on the Pre-Altai Plain is determined, first of all, by the influence of the forest cover, swampiness, differences in relief and associated flooding during high water, steppe development, construction of buildings, and the water content. These factors explain the types of preference distinguished. In the rank of subtypes, the bird distribution is influenced by the composition of forest-forming species, differences in the degree of overgrowth of floodplain habitats, plowing, grazing, type of building up the area, size of watercourses, and flowage. In the rank of classes, the residual influence of all the previously mentioned factors was traced.

According to the results of the analysis, we can say that the classifications of bird species according to the commonality of preferences for certain habitats on the Pre-Altai Plain and in other provinces of Altai are relatively similar (Table 1).

In the mountains, just like on the Pre-Altai Plain, most bird species prefer forests in the first half of summer. The proportion of such species ranges from 26% in the study area to 46% in Northwestern and Northern Altai. Approximately half as many species gravitate

**Table 1.** The number of bird species that prefer different habitats in the provinces of the Altai mountain region in the first half of summer

| Habitats                         | Province        |                       |                       |                   |                  |
|----------------------------------|-----------------|-----------------------|-----------------------|-------------------|------------------|
|                                  | Pre-Altai Plain | Northeastern province | Northwestern province | Northern province | Central province |
| Subnival habitats                | —               | —                     | —                     | —                 | 5                |
| Alpine—tundra habitats           | —               | 4                     | —                     | 9                 | 16               |
| Subalpine—sparse forest habitats | —               | 10                    | 16                    | 6                 | 15               |
| Forest habitats                  | 46              | 79                    | 61                    | 62                | 85               |
| Meadow—steppe and field habitats | 37              | 18                    | 28                    | 38                | —                |
| Steppe habitats                  | 3               | —                     | —                     | —                 | 42               |
| Floodplain habitats              | 32              | 22                    | —                     | —                 | —                |
| Swamp habitats                   | 18              | 17                    | —                     | —                 | 15               |
| Residential habitats             | 14              | 12                    | 18                    | 8                 | 11               |
| Rivers                           | 25              | 13                    | 11                    | 12                | 17               |
| Lakes                            | —               | 12                    | —                     | —                 | 7                |
| Total number of species          | 175             | 187                   | 134                   | 135               | 213              |

\* Materials for all Altai provinces, except for the Pre-Altai Plain, were taken from published sources (Toropov and Grazhdan, 2010; Bochkareva and Irisova, 2009; Tsybulin, 1999; Bochkareva and Livanov, 2013).

to open meadow—steppe, field, and steppe habitats. Such species are the most numerous in the Northern, Pre-Altai, Northwestern, and Central provinces (28, 22, 21, and 20%, respectively) and least numerous in the most forested Northeastern province (10%). The birds that are typical of floodplain habitats were noted only in the Pre-Altai Plain and Northeastern Altai (18 and 12%), and those that are typical of low-lying swamps, where they were surveyed, were noted in the Pre-Altai, Northeastern, and Central provinces (7–10%). The proportion of bird species that prefer human settlements is generally low and is about 5–8%. However, in Northwestern Altai, where the counts were carried out in semi-abandoned settlements attracting a relatively large number of species, their share reaches 13%. Aquatic and semi-aquatic habitats in all provinces of Altai are preferred by an approximately equal and small part of birds. In the mountains, where alpine landscapes are represented, the share of birds of alpine—subalpine—meadow, tundra, and light forest habitats is the highest in the Central Altai (17%) and is less in Northeastern Altai (7%). Compared to the mountainous areas, forest landscapes on the Pre-Altai Plain are preferred by a significantly smaller number of species, which is probably due to their lower diversity and greater preference for floodplain and marsh tracts by birds. This is due to the significant aridity and high level of plowing on the territory of the Pre-Altai province in comparison with the mountainous regions.

Analyzing the number of common species that prefer certain habitats on the Pre-Altai Plain and in the mountainous provinces of Altai, we can note the fol-

lowing. Among the birds gravitating to forest habitats, the largest number of species was noted to be common with Northeastern Altai (41), and a slightly smaller number of species were common with Northern and Central Altai (36–38), and the smallest number of them was in common with Northwestern Altai (28). The list of birds that prefer open meadow—steppe, field, and steppe tracts of the Pre-Altai Plain was noted to be the most common with Northern and Central Altai (16 for each) and least common with Northeastern and Northwestern Altai (8–10). These differences in the number of common species are due to the degree of remoteness of the territories from each other, as well as the similarity in forest cover, mosaicity, and moisture content and in the volume of surveys carried out in these territories. The list of common birds that prefer settlements in all provinces of the Altai mountain region ranges from five to seven species. Of these, the Rock Pigeon, Common Swallow, House Sparrow, Tree Sparrow, and Jackdaw were recorded in all the provinces compared. Among the birds that prefer the aquatic and semi-aquatic habitats of the Pre-Altai Plain, the greatest number of common species was noted in Northeastern Altai (11), which is due to the close location of these provinces, as well as the fact that the counts were carried out in both cases within the water area of the Biya River. Somewhat less similarity was noted with the watercourses of Northwestern, Northern, and Central Altai (7–9). At the same time, in all provinces of the Altai mountain region, species such as the Gray Gull, Common Sandpiper, Kingfisher, and Gray Wagtail were noted.

When comparing the classification of bird species of the Pre-Altai Plain with the plain territories of the Tobol–Irtysh forest–steppe and steppe, as well as the outlier steppe of Western Siberia (Toropov, 2008; Solovyov, 2012), attention is drawn to the relatively high proportion of birds preferring aquatic and semi-aquatic habitats there (28 and 39%, respectively). In the Tobol–Irtysh forest–steppe and steppe, a significant proportion of birds gravitate to water bodies (26%), among which the largest number of species is characteristic of lakes with reed thickets (20%). In addition, a clear preference for forests (22%), lowland swamps (18%), and open meadow–steppe, field, and steppe habitats (11%) was noted. In the outlier steppe of the Ob–Irtysh interfluvium, almost half of all species gravitate to open steppe and field tracts (44%). A quarter of the species prefer small rivers (26%), and reed swamps and lakes are preferred by 7 and 2%, respectively. At the same time, both territories are similar to the Pre-Altai Plain in the number of species that prefer human settlements (9–10%), which indicates a significant anthropogenic transformation of the landscapes of the forest–steppe and steppe regions.

*Classification of Bird Species according to the Similarity of Distribution in the Second Half of Summer*

All 158 bird species are grouped into three super-types according to habitat preference, just like for the first half of summer: species of undeveloped and built-up land, as well as aquatic and semi-aquatic communities.

*Birds That Prefer Undeveloped Habitats*

**(1) Forest type of preference** (Honey Buzzard, Buzzard, Greater Spotted Woodpecker, Mistle Thrush, Siberian Rubythroat, Willow Tit).

Birds that prefer the following:

(1.1) pine forests (Hazel Grouse, Capercaillie, Night-hawk, Black Woodpecker, European Pied Flycatcher, Coal Tit, Common Chaffinch, Bullfinch) and

(1.1.1) floodplain willow meadows (Cuckoo);

(1.2.1) meadows alternating with copses (Tree Pipit);

(1.2) birch–pine forests (Sparrow Hawk, Golden Eagle, Raven);

(1.3) birch forests (Ural Owl and Great Gray Owl, Oriole);

(1.4) wet birch–aspen forests (Common Long-eared Owl, Red-winged Thrush, Nightingale, European Chiffchaff, Common Treecreeper, Nutcracker) and

(1.4.1) pine forests (Song Thrush, Nuthatch, Jay).

**(2) Floodplain type of preference** (Fieldfare, Eurasian Long-tailed Tit).

Birds that prefer the following:

(2.1) willow meadows (Pigeon Hawk, Common Moorhen, Marsh Snipe, Stone Plover, Red-necked Phalarope, Whinchat, Yellow-browed Warbler, Common Bunting) and

(2.1.1) lowland swamps (Yellow-headed Wag-tail);

(2.1.2) fields (Land Rail);

(2.2) shrub meadows (Booted Eagle, European Bee Eater, Lesser Spotted Woodpecker and White-backed Woodpecker, Spotted Flycatcher, Greenish Warbler, Eurasian Whitethroat, Lesser Whitethroat, Azure Tit, Siskin, Long-tailed Rosefinch, Common Rosefinch) and

(2.2.1) lowland swamps (Blyth's Reed Warbler);

(2.2.2) fields (Hoopoe, Eurasian Goldfinch);

(2.2.3) meadow-field landscapes (European Hobby).

**(3) Steppe type of preference.**

Birds that prefer feather-grass steppes (Upland Buzzard, Common Wheatear).

**(4) Meadow-field type of preference** (Common Kestrel, Pale Harrier, Steppe Eagle, Marsh Owl, Sky Lark, Asian Stonechat? (Stonechat)).

Birds that prefer the following:

(4.1) meadows alternating with copses (Black Grouse, Goshawk, Little Stint, Wryneck, Eastern Tree Pipit, Brown Shrike) and

(4.1.1) lowland swamps (Pine Bunting);

(4.1.2) floodplain willow meadows (Radde's Warbler);

(4.1.3) lowland swamps and floodplain willow meadows (Brown Shrike);

(4.2) pasture meadows (Saker Falcon, Montagu's Harrier, Greater Spotted Eagle, Imperial Eagle, Common Swift, Steppe Pipit, Isabelline Wheatear);

(4.3) fields (Willow Ptarmigan and Gray Partridge, Quail, Crested Honey Buzzard, Hen Harrier, Demoiselle Crane, Stock Dove, Eastern Grasshopper, Booted Warbler, Common Crossbill, Ortolan Bunting and Red-headed Bunting) and

(4.3.1) floodplain shrub meadows (Eastern Turtle Dove, Eurasian Linnet).

**5. Swamp type of preference.**

Birds that prefer lowland swamps (Common Crane, Grasshopper Warbler and Lanceolated Warbler, Willow Warbler and Dusky Warbler, Garden Warbler, Bramble Finch) and

(5.1) floodplain willow meadows (Blue-throated Robin, Yellow-breasted Bunting).

*Birds That Prefer Built-up Habitats*

**(6) Residential type of preference** (Rock Pigeon, Magpie, Gray Crow, House and Tree Sparrow).

Birds that prefer the following:

(6.1) settlements (Common Swallow, Jackdaw) and

(6.1.1) meadow—field landscapes (Rook);

(6.1.2) rivers (Black Kite, Masked Wagtail);

(6.2) only large settlements (Greenfinch, Gray-headed Goldfinch);

(6.3) only small settlements (Hawfinch, Eastern Black Crow? (Black Crow));

(6.4) areas of urban development (European Redstart) and

(6.4.1) pine forests (Great Tit);

(6.5) areas of urban high-rise buildings (Pacific Swift, Common House Martin);

(6.6) areas of urban one-story buildings (White Wagtail, Waxwing).

*Birds That Prefer Aquatic and Semi-Aquatic Habitats*

**(7) River type of preference** (Gadwall, Common Pintail, Common Shoveler).

Birds that prefer the following:

(7.1) small rivers (Common Teal, Mallard, Garganey, Tufted Duck, Common Cormorant, Marsh Harrier, Northern Lapwing, Little Ringer Plover, Common Snipe, European Curlew, Gray Gull, Temminck's Stint, Starling) and

(7.1.1) fields (Yellow Wagtail);

(7.1.2) medium rivers (Kingfisher, Common Sand Martin);

(7.2) medium and small rivers (Common Sandpiper, Gray Wagtail);

(7.3) medium rivers (Gray Heron, Redshank);

(7.4) large rivers (Common Merganser, Black Stork, Red-footed Falcon, Peregrine Falcon, Common Pied Oystercatcher, Heuglin's Gull? (Herring gull), Common Gull and Common Black-headed Gull, Common Tern).

In the second half of summer, most birds prefer open meadow—field landscapes (36 species, 23%), while rivers and forests attract 32 and 31 species, respectively (20% each). As before, a significant number of birds prefer floodplain habitats (28 species, 18%), and the number of birds gravitating to settlements increases compared to the first half of summer (20 species, 13%). In the second half of summer, birds least of all prefer swamps (nine species, 6%) and steppes (two species, 1%).

Compared with the first half of summer, the proportion of birds that prefer forests and lowland swamps decreases in the second half of summer due to the completion of breeding and post-breeding migrations

and drying up of marsh tracts, but the number of species that prefer rivers and residential habitats increases. The total proportion of species that form the meadow—field and floodplain type of preference during the summer almost does not change.

When comparing the classification schemes for the first and second half of the summer, it can be noted that each type of preference includes species that do not change their preference during the summer. The largest proportion of these species is characteristic of rivers and settlements (61 and 48%) and is slightly less typical of forests and meadow—field habitats (38% for each). The smallest proportion of species that do not change the type of preference is characteristic of lowland swamps and floodplain habitats (28 and 20%). The rest of the species is represented by birds with a clear post-breeding change in the nature of preference. So, in the second half of the summer, the following species from the group of birds that prefer typically forest habitats were transferred to the floodplain group: the Lesser Spotted Woodpecker and White-backed Woodpecker, Fieldfare, Spotted Flycatcher, Yellow-browed Warbler, Eurasian Long-tailed Tit, and Siskin; the species that were transferred to the swamp group included the Bramble Finch, and those that were transferred to the group gravitating to open and slightly forested tracts included the Red-backed Shrike and Common Crossbill. On the contrary, the following species moved to forest tracts from open and slightly forested habitats: the Honey Buzzard, Sparrow Hawk, Buzzard, and Golden Eagle; the species that moved to them from floodplain habitats included the Common Long-eared Owl and Nightingale. The species that moved to them from marsh habitats included the Cuckoo. In addition, some species in the second half of summer are characterized by a change in not only the type of preference, but also the super-type. Thus, the species that moved to human settlements from forest habitats included the European Redstart, Waxwing, Great Tit, Greenfinch, and Hawfinch. The species that moved to them from meadow—field habitats included the Black Kite, Pacific Swift and Gray-headed Goldfinch, and the species that moved to them from river habitats included the Masked Wagtail. On the contrary, of the species that previously preferred settlements, the Raven, Greenish Warbler, and Common Swift were assigned in the second half of summer to the forest type of preference, floodplain type, and meadow—field type, respectively. Rivers are preferred in the second half of summer by the Red-footed Falcon, Marsh Harrier, Common Snipe, European Curlew, Redshank, and Yellow Wagtail, which were assigned in the first half of summer to the marsh, floodplain, and meadow—field types of preference.

As in the first half of summer, the main role in the differentiation of bird distribution belongs to forest cover, flooding during the high water period, steppe development, swampiness, the level of building-up, and

**Table 2.** The number of bird species that prefer different habitats in the provinces of the Altai mountain region in the second half of summer

| Habitats                         | Province        |                       |                       |                   |                  |
|----------------------------------|-----------------|-----------------------|-----------------------|-------------------|------------------|
|                                  | Pre-Altai Plain | Northeastern province | Northwestern province | Northern province | Central province |
| Subnival habitats                | —               | —                     | —                     | —                 | 4                |
| Alpine—tundra habitats           | —               | 4                     | —                     | 10                | 24               |
| Subalpine—sparse forest habitats | —               | 8                     | 19                    | 7                 | 19               |
| Forest habitats                  | 31              | 75                    | 40                    | 48                | 68               |
| Meadow—steppe and field habitats | 36              | 13                    | 18                    | 36                | —                |
| Steppe habitats                  | 2               | —                     | —                     | —                 | 40               |
| Floodplain habitats              | 28              | 22                    | —                     | —                 | —                |
| Swamp habitats                   | 9               | 11                    | —                     | —                 | —                |
| Residential habitats             | 20              | 19                    | 21                    | 8                 | 18               |
| Rivers                           | 32              | 6                     | 12                    | 12                | 18               |
| Lakes                            | —               | 10                    | —                     | —                 | 8                |
| Total number of species          | 158             | 168                   | 110                   | 121               | 199              |

water content. A less important role is played by the composition of forest-forming species, differences in the degree of overgrowth of floodplain habitats, plowing, grazing, type of building-up the area, and the size of settlements and watercourses, as well as flowage.

In the mountainous provinces of Altai, most birds prefer forests in the second half of summer, but their proportion is somewhat smaller (34–45%) compared to the first half of summer (Table 2).

During the summer, the number of species that prefer open meadow-field habitats and steppes almost does not change in the provinces. Their share ranges from 30% in Northern Altai to 23 and 20% in the Pre-Altai Plain and in Central Altai. It is somewhat less in Northwestern Altai (16%) and minimal in Northeastern Altai (8%). Just like on the Pre-Altai Plain, the proportion of birds that are characteristic of marsh habitats significantly decreases in the second half of summer in Northeastern Altai (6% for each), while the proportion of birds that live in floodplains remains at the same level (18 and 13%). In all provinces of the Altai mountain region compared, the number of species that prefer settlements and high-mountain alpine—subalpine-meadow and tundra landscapes increases significantly in the second half of summer. At the same time, compared with the first half of summer, the species in the residential habitats of the Pre-Altai Plain and Northeastern and Central Altai were replenished with 6–7 bird species, and the species in the highlands of Northern, Northwestern, and Central Altai were replenished with two, three, and eleven species, respectively. During the summer, approximately the same number of birds stay on the rivers of the mountainous provinces of Altai, and on the Pre-Altai Plain in the second half of summer their number

increases by seven species, which is due to post-breeding migrations (Crested Duck, Common Merganser, Common Snipe, European Curlew, Yellow Wagtail) as well as autumn migrations of some species (Common Cormorant and Temminck's Stint).

Among the birds that prefer forests on the Pre-Altai Plain, just like in the first half of summer, the largest number of species was noted to be common with Northeastern Altai (27) and a slightly lesser number was noted to be common with Central Altai (24). In Northern and Northwestern Altai, a decrease in the number of common species was noted due to the smaller number of birds that prefer forests (17–18). In all the provinces of the Altai mountain region, 16 common species gravitate to forests: Hazel Grouse, Capercaillie, Sparrow Hawk, Ural Owl, Greater Spotted Woodpecker, Black Woodpecker, Song Thrush, Siberian Rubythroat, European Chiffchaff, Willow Tit, Coal Tit, Nuthatch, Oriole, Jay, Common Chaffinch, and Bullfinch. The species list of birds gravitating to open meadow—field and steppe tracts of the Pre-Altai Plain is most similar in the number of common species to that for Northeastern, Northern, and Central Altai (13–15). At the same time, such habitats are preferred in all provinces by four species: Quail, Gray Partridge, Steppe Pipit, and Eurasian Linnet. As in the first half of summer, the species that were noted in the settlements of all compared provinces included the Rock Pigeon, Common Swallow, and House and Tree Sparrows. However, the provincial examination showed that the list of birds from the settlements of the Pre-Altai Plain was the most similar to those of Northeastern and Northwestern Altai (14 and 12 common species). In addition to the above four species, these territories are also united by the presence of the

Common House Martin, Masked Wagtail, European Redstart, Magpie, and Gray Crow. Among the birds that prefer the aquatic and semi-aquatic habitats of the Pre-Altai Plain, the greatest number of species was common with Central and Northwestern Altai (12 and 10) and somewhat fewer species were common with Northern and Northeastern Altai (6–8). At the same time, with the exception of the Northeastern province, rivers are preferred in all territories of the Altai mountain region by the Common Merganser, Gray Gull, Common Sandpiper, Kingfisher, and Gray Wagtail.

The plain steppe and forest–steppe territories of Western Siberia in the second half of summer are characterized by changes in the territorial distribution of birds that are similar to those of the Pre-Altai Plain (Toropov, 2008; Solovyov, 2012). Against the background of a decrease in the number of species that prefer forests and lowland swamps, the proportion of birds that live in aquatic and semi-aquatic habitats increases. In the Tobol–Irtys forest–steppe and steppe, the proportion of such species increased from 28 to 42% compared with the first half of summer; among them 25% tend to lakes with reed thickets and 14% gravitate to open water bodies. The number of forest bird species decreased compared with the first half of the summer by 15 species and amounted to 17%, and the number of birds that prefer lowland swamps decreased by 28 species and amounted to only 7%. In addition, in the second half of summer, the proportion of birds that are characteristic of settlements increases slightly (from 9 to 11%). In the outlier steppe of the Ob–Irtys interfluvium, almost half of all species (43%) prefer aquatic and semi-aquatic habitats, of which 16% gravitate to rivers and 12 and 10% gravitate to open and reed lakes. The number of species that live along rivers and lakes is higher than on the Pre-Altai Plain due to the greater representation of various reservoirs with reed thickets in the steppe zone of Western Siberia and, accordingly, the better supply of food for them and the availability of places for nests and shelters.

## CONCLUSIONS

The analysis of the distribution of birds and their preference for different habitats made it possible to identify the following types of preferences: forest, meadow–field, steppe, floodplain, swamp, river, and residential types. The leading role in the differentiation of bird species according to the types of preference belongs to forest cover, swampiness, differences in relief, steppe development, degree of building-up the area, and water content.

In the first half of summer, the largest number of bird species prefers forests, and a slightly smaller number of birds species prefers meadow–field and floodplain habitats. The preference for rivers, swamps, and residential habitats is less by an order of magnitude, and steppes are preferred by birds least of all. The sec-

ond half of summer brings about a decrease in the number of species that tend to forests and lowland swamps and an increase in the number of those that prefer settlements and rivers. These changes are due, on the one hand, to the transformation of habitats (in the form of drying out of lowland swamps), and, on the other hand, they are caused by post-breeding migrations, autumn migrations, and the redistribution of birds to the habitats that are the most abundant in food and favorable for each specific species.

When comparing the classification of bird species according to the preference for habitats of the Pre-Altai Plain and the mountainous provinces of Altai, as well as the plain forest–steppe and steppe territories in the southern part of Western Siberia, we revealed a relatively similar bird distribution pattern. In all territories compared, the number of species that prefer forests and swamps was noted to decrease in the second half of summer, but the number of species gravitating to residential as well as aquatic and semi-aquatic habitats increased. Differences in the spatial bird distribution in the compared territories are due to the predominance of forest–steppe, meadow–steppe, and field landscapes on the Pre-Altai Plain, as well as the significantly lower diversity and smaller area of forest habitats, which are characteristic of the Altai mountain provinces. Nevertheless, the Pre-Altai Plain is more similar in the nature of the distribution of bird species to the mountain provinces of Altai than to the forest–steppe and steppe territories of the Tobol–Irtys and Ob–Irtys interfluviums in the southern part of the West Siberian Plain. The territory of the latter is characterized by the presence of a large number of fresh and slightly saline lakes and, accordingly, a large number of bird species belonging to the aquatic and semi-aquatic type of preference. Differences in the number of common bird species between the Pre-Altai Plain and other provinces of Altai depend on the connection of territories, ratio of areas of forested, mosaic, and open tracts, the density of the river network, and, accordingly, the number of species that prefer groups of habitats in a particular province. In addition, interseasonal changes in the number of common species may be due to post-breeding migrations, habitat transformation, and the redistribution of birds over habitats with the most optimal conditions in the second half of summer.

## ACKNOWLEDGMENTS

The authors are grateful to the head of the laboratory of zoological monitoring at the Institute of Systematics and Ecology of Animals, Siberian Branch, Russian Academy of Sciences, Yu.S. Ravkin, for comments and editing of the manuscript.



## COMPLIANCE WITH ETHICAL STANDARDS

The authors declare that they have no conflicts of interest. This article does not contain any studies involving animals or human participants performed by any of the authors.

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Translated by L. Solovyova