Stray bird species are reference points of the initial stages of changing areas in conditions of directional climate change (on the example Eastern Siberia)

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Abstract. We have shown that Eastern Siberia has now become the scene of climate change, which is determined by its location – the center of Inner Asia. It was found that as a result of increased solar activity on the western edge of Eurasia, the latitudinal transfer of air masses was replaced by a meridional (North Atlantic sector) one. Later, such a shift was observed in the eastern (Pacific) sector of Asia. As a result, a hotbed of elevated surface air temperature was formed in Eastern Siberia and adjacent areas of Mongolia and China, and distant bird evictions to the north, east and west were observed. It is shown that such flights are the first stage of the transformation of bird areas. In the first half of the 20th century, weak western and eastern bird streams have already reached of the hollow Lake Baikal. By the middle of the 20th century, 60 new bird species had been recorded here, but their numbers were insignificant. Subsequently, there were clear trends among them towards further expansion of their areas. It is proved that long-range flights of new species are the first benchmarks indicating the upcoming changes in bird areas. Their consequences should be taken into account in economic activities.

1 Introduction

The study of birds in Eastern Siberia has a long history and the first information obtained in this area dates back to the XVIII-XIX centuries [1-8]. In the first half of the 20th century, significant materials on the bird fauna of this region and adjacent territories were also collected [9-24]. Despite this, the composition of the bird fauna of Eastern Siberia has not yet been precisely clarified [25]. There are many reasons for the incomplete study of the bird fauna of this region, and the main one is the dynamics of climatic conditions over the past centuries [26-27]. Actually, this period refers to the time of the beginning of climate warming after the Little Ice Age of the European territory of Eurasia [28]. Climate warming increased dramatically in the second half of the 20th century, although the first half of it still belonged to the Late Glacial period [29]. This process was accompanied by a strong

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outflow of birds from the Southern regions of Inner Asia to the northern borders of the 3reals, as well as to the west and east of the regions covering their optima [25-27]. In turn, changes in the general circulation of the atmosphere in the northern latitudes contributed to the penetration of a number of species of the tundra zone into temperate latitudes [30-32].

The initial processes of re-formation of bird ranges are associated with flights of species atypical for a particular region and a gradual increase in the frequency of their encounters. In some cases, the mass appearance of a new species is possible immediately, but after a relatively short period of high abundance, a sharp decrease in its number is observed, up to almost complete extinction [31-32]. At the same time, it is the initial processes of climate warming that have caused changes in bird ranges that are still poorly understood. In the middle of the last century, a large six-volume summary of the birds of the Soviet Union was published [33]. However, Eastern Siberia is lost in this vast data. It was necessary to consider it separately, since the physical and geographical specificity of this region determined many of the initial stages of these processes [29, 34-35].

The materials of the first stages of studying the bird fauna of Eastern Siberia were summarized by the famous Siberian ornithologist, professor, Doctor of Biological Sciences T.N. Gagina [21-23]. They also included the first information about the flights of bird species not typical for the region, which allows us to specifically consider the features of such evictions to the boundaries of the ranges and their expansion at the initial stages of noticeable climate warming. This makes it possible to analyze in more detail the features of the dynamics of bird ranges of the current Holocene period, the last stage of the modern interglacial [28-29, 34, 36]. In this article, bird flights are specifically considered as the initial stages of the transformation of their habitats in conditions of directional climate change.

The identification of the main patterns of the transformation of bird ranges in the interglacial periods, which include the modern stage of the Holocene, is one of the priorities of evolutionary ecology. A special study of them will make it possible to clarify a number of issues related to the dynamics of bird fauna over long geological epochs. In turn, their solution makes it possible to use the results obtained both for the further development of major fundamental areas of science and for practical use (conservation, hunting, environmental protection).

2 Research area, material and methodology

Eastern Siberia is predominantly a mountainous country with a large number of plateaus. It is located in the center of Asia, at the junction of steppe and forest zones (south taiga forests). Everywhere here, with the exception of the Sayano-Baikal Stanovoi and Khentei-Chikoi highlands, which have heights from 2500 m to 3500 m, the medium-mountain relief (800-1800 m) prevails, the plain spaces are small, and the lowlands occupy an insignificant area [37]. Its entire territory is divided into two unequal parts by the Baikal rift zone, running from the southwest (from Lake Khubsugul) to the northeast (left bank of the Olekma River) - Pre-Baikal and Transbaikalia. The central link of this rift is Lake Baikal, which occupies its deepest part. The total length of the Baikal rift zone exceeds 2000 km and it is characterized by very high seismicity. Individual earthquakes here reach a strength of 10-11 points. Extensive intermountain basins are an important element of the relief of the southern regions of Eastern Siberia. Sections of the zonal steppes entering from the territory of Mongolia and Northern China are wedged here. Through treeless intermountain basins, steppes can rise high into the mountains, forming a belt of mountain steppes. Steppe and forest-steppe areas are also found along the Angara River and the lower sections of its large tributaries, as well as on Olkhon Island and in the Priolkhonye region [29, 34].

Eastern Siberia is characterized by a very well-developed river network. It belongs to the basins of the three largest rivers in Siberia: The Yenisei, Lena and Amur Rivers are distinguished, with the exception of the Uldza-Torey basin, by a very large density. The rivers' nutrition is mixed – snow and rain. The main source of atmospheric moisture is the western and eastern air flows. The main territory is characterized by a wide distribution of island permafrost. There are very few large lakes of natural origin here. Small thermokarst lake-marsh ecosystems located in the valleys of rivers and springs, as well as lakes derived from the riverbed, prevail everywhere [38].

The climate of this territory, with the exception of the Baikal basin, is moderately continental and sharply continental, but in deep basins it is ultracontinental. The basin of Lake Baikal, due to its huge water mass, is characterized by a relatively mild winters and cool summers (seaside climate). The transfer of air masses from the northwest and warm humid ones from the south (monsoons) prevails, but at present the probability of cold air inflows from the north is very high. The amount of precipitation increases from west to east – from 300 mm to 500 mm per year, but in forest-steppe basins there are fewer of them, about 250-300 mm per year [39]. The plains, including Lake Baikal, are characterized by very strong winds, sometimes reaching gale force. The frequency of their repetition increases markedly in the autumn and early spring.

Pine forests predominate in the south of the territory. The wetter areas are occupied by larch-cedar and cedar forests, but large clean forests of Siberian pine (cedar) *Pinus sibirica* are common only on the Leno-Angarsk and Prilensky plateaus, as well as on the northeastern coast of Lake Baikal. Pure larches are widespread in the northern regions. The floodplains are characterized by forests of Siberian spruce *Picea obovata* and Siberian fir *Abies sibirica* with an admixture of Siberian larch *Larix sibirica* and cedar. The upper reaches of rivers and small springs and rivers are usually occupied by swamps, swampy forests or vineyards (various types of shrubby birches), especially on frozen marsh soils [29].

In the Transbaikal natural area (the geoecological core of Eurasia), air flows coming from the Atlantic and Pacific Oceans, the Arctic and southern adjacent territories are significantly weakening and sometimes attenuating [35]. Orographic barriers represented by the ridges of the Eastern Sayan, Baikal, Khamar-Daban and Barguzin ridges significantly reduce the level of humidification of northwestern air flows. In addition, the moisture-saturated Pacific monsoons are weakened by the ridges of the Olekminsky Stanovik and Bolshoy Khingan. Air flows from the Arctic Ocean lose moisture on the slopes of the Baikal-Patomsky Highlands, the North Muisky and Kodar ranges [35]. As a result, Transbaikalia is located in a zone of rain shadow and low precipitation formation [35]. During prolonged dry periods, these processes extend to the Pribaikal region.

The work is based on the materials of faunal studies from the end of the XYII to the first half of the XX centuries. A special analysis was carried out for each stray species. The conditions under which it was discovered and the possibility of its appearance here during this period were determined. Generalized data on fairly large areas with approximately the same physical and geographical conditions were compared with the materials of T.N. Gagina [21-23]. Based on such comparisons, the composition of birds and its differences in different periods of research were clarified. When processing the materials, standard statistical approaches or more special methods were used that most fully characterize the studied parameters of the bird population [40]. In order to clearly and fully identify the flow of dispersing birds, which is based on migratory species, it is necessary to have a good knowledge of the composition of the bird fauna of neighboring regions. We paid special attention to this aspect of the problem and got acquainted with the main works on the bird fauna of adjacent territories [24, 41-44].

3 Results

The end of the XIX and the first half of the XX centuries, according to the instructions of a number of authors, still belong to the Late Glacial period [29]. At the same time, the initial processes of climate warming during this period were very poorly expressed [15, 17, 18-20, 25-27, 31-32]. However, by this time there had already been quite pronounced movements in bird ranges, as indicated by the materials of various researchers who worked from the northwestern outskirts of Russia to the Yamal Peninsula [15, 18-23]. At the same time, throughout the first half of the 20th century, very little warming was observed up to the western outskirts of Eastern Siberia [10-11, 15-20, 26-27, 45] Despite this, materials have appeared indicating very specific cases of expansion of the ranges of a number of bird species in Eastern Europe and Western Siberia to the north [10, 15-20]. Therefore, it is now possible to analyze the initial stages of bird evictions outside their ranges and understand their causes. The most suitable for such an analysis are stray bird species. A complete list of them, obtained in Eastern Siberia, allows us to consider the issues of interest in more detail (Table 1).

Table 1. Stray bird species in Eastern Siberia (mid-XYII – first half of XX centuries) (according to the materials 6, 8, 21-24, 33).

N	Species	Direc-tion of move-ments	Pred-baika-lia	Lake Baikal Hol-low	Trans-baika-lia
1	Little Grebe *Podiceps ruficollis*	to west	err.Rr	-	-
2	Black-necked Grebe *Podiceps nigricollis*	to east	err.R	err.R	tr.r(n)
3	Dalmatian Pelican *Pelecanus crispus*	to east	err.Rr	err.Rr	-
4	Chinese Pond Heron *Ardeola bacchus*	to west	-	-	err.Rr
5	Spoonbill *Platalea leucorodia*	to west	err.Rr	err.Rr	n.R
6	Flamingo *Phoenicopterus roseus*	to east	err.Rr	err.Rr	-
7	Red-breasted Goose *Branta ruficollis*	stay	tr.R	-	-
8	Snow Goose *Anser caerulescens*	stay	tr.Rr	tr.Rr	tr.Rr
9	Schelduck *Tadorna tadorna*	to west	err.Rr	err.Rr	nc
10	Eastern Spot-billed Duck *Anas (poecilorhyncha) zonorthyncha*	to west	err.R	nR	nc
11	Mandarin Duck *Aix galericulata*	to west	err.Rr	-	err.Rr
12	Common Scoter *Melanitta nigra*	stay	err.Rr	-	-
13	Velvet Scoter *Melanitta fusca*	stay	-	-	err.Rr
14	White-headed Duck *Oxyura leucocephala*	to east	-	err.R	-
15	Pallid Harrier *Circus macrourus*	to east	err.Rr	-	n.Rr
16	Upland Buzzard *Buteo hemilasius*	to west	err.R.	-	nhyem
17	Long-legged Buzzard *Buteo rufinus*	to east	err.R	-	-
18	Short-toed Eagle *Circaetus gallicus*	to east	-	-	err.Rr
19	Steppe Eagle *Aquila nipalensis*	to east	err.Rr	err.Rr	n.c
20	Imperial Eagle *Aquila heliaca*	to west	err.R	n.Rr	n.r
21	Bearded Vulture *Gypaetus barbatus*	to west	err.Rr	err.Rr	-
22	Merlin *Falco columbarius*	stay	err.Rr	-	-
23	Lesser Kestrel *Falco naumanni*	to west	err.R	-	n.c
24	Grey Partridge *Perdix perdix*	to east	-	err.Rr	-
25	Yellow-legged Buttonquail *Turnix tanki*	to west	err.Rr	err.Rr	err.Rr
26	Red-crowned Crane *Grus japonensis*	to west	-	-	err.Rr
27	Moorhen *Gallinula chloropus*	to west	-	-	err.Rr
28	Oriental Plover *Charadrius veredus*	to north	-	err.Rr	n.r
29	Avocet *Recurvirostra avosetta*	to north	err.Rr	err.Rr	n.r
30	Marsh Sandpiper *Tringa stagnatilis*	to north	err.R	n.r	n.c
31	Calidris canutus *Calidris canutus*	stay	-	err.Rr	-
32	Western Sandpiper *Calidris mauri*	stay	-	err.Rr	-
33	Far Eastern Curlew *Numenius madagascariensis*	stay	tr.Rr	tr.Rr	n.r
34	Bar-tailed Godwit *Limosa lapponica*	stay	-	tr.Rr	-

N	Species	Direc-tion of move-ments	Pred-baika-lia	Lake Baikal Hol-low	Trans-baika-lia
35	Pomarine Skua *Stercorarius pomarinus*	stay	err.Rr	err.Rr	-
36	Paeasitic Skua *Stercorarius parasiticus*	stay	err.Rr	err.Rr	err.Rr
37	Glaucous Gull *Larus hyperboreus*	stay	err.Rr	err.Rr	err.Rr
38	Kittiwake *Rissa tridactyla*	stay	-	err.Rr	-
39	White-winged Black Tern *Chlidonias leucopterus*	to west	-	err.Rr	n.c
40	Red Turtle-dove *Streptopelia tranquebarica*	to west	-	-	err.Rr
41	Oriental Scops Owl *Otus sunia*	to west	-	-	err.Rr
42	Tawny Pipit *Anthus campestris*	to east	-	err.Rr	-
43	Pechora Pipit *Anthus gustavi*	stay	-	err.Rr	tr.Rr
44	Meadow Pipit *Anthus pratensis*	to east	-	err.Rr	-
45	Blue-headed Wagtail *Motacilla flava*	to east	err.Rr	-	-
46	Chinese Yellow Wagtail *Motacilla macronix*	to west	-	err.R	n.c
47	Chinese Grey Shrike *Lanius sphenocercus*	to west	-	err.Rr	err.Rr
48	Starling *Sturnus vulgaris*	to east	n.r	err.R	err.R
49	Azure-winged Magpie *Cyanopica cyanus*	to west	err.R	err.R	n.c
50	Hooded Crow *Corvus cornix*	to east	err.Rr	err.Rr	-
51	Oriental Reed Warbler *Acrocephalus orientalis*	to west	err.Rr	err.R.	n.r
52	Hume's Warbler *Phylloscopus humei*	to east	-	err.Rr	-
53	Grey-streaked Flycatcher *Muscicapa griseisticta*	to west	err.Rr	-	-
54	Thrush Nightingale *Luscinia luscinia*	to east	err.Rr	-	-
55	Mistle Thrush *Turdus viscivorus*	to east	n.R	err.Rr	err.Rr
56	Siberian Penduline *Remiz coronatus*	to west	-	err.Rr	n.Rr
57	Chaffinch *Fringilla coelebs*	to east	-	err.Rr	-
58	Chestnut-eared Bunting *Emberiza fucata*	to west	-	err.nr	n.R
59	Black-headed Bunting *Granativora melanocephala*	to east	-	err.Rr	-
60	Ochre-rumped Bunting *Emberiza yessoensys*	to west	err.Rr	-	-
	Total	60	35	40	35

Annotation: err – stray bird, tr – flight, n – nesting, (n) – nesting is possible, but not proven, hyem – wintering, c – a common species, r – a rare species, R – a very rare species, Rr – a chance encounter. Range expansion: to west – to the west, to east – to the east, to north – to the north, stay – stop during flight. *Source: compiled by the author*.

In the middle of the XX century, 60 species of stray bird species, i.e. new to the region, were recorded in Eastern Siberia, the total number of which included 376 species (taking into account the new status of subspecies transferred to species). Consequently, the share of migratory bird species in its total fauna was 16.0%. We cannot say how large this value is, since there have been no precedents for such an analysis yet. However, it is very important that we received these materials at the initial stages of climate warming in a very large region. A sufficiently large number of new bird species makes it possible to conduct a full-fledged analysis of their composition and identify the main reasons for their appearance in Eastern Siberia. In addition, it should be borne in mind that previously many bird species in this region had a gap in their ranges. As a result, the once unified ranges of ancestral forms were divided into several sections. In each of them, new subspecies and species were formed over time, which dramatically increased the diversity of birds in adjacent regions [45].

First of all, it should be noted that the response of birds to climate warming varies greatly in different ecological groups of their species. Already at the first stages of climate warming, a large number of species of near-water and waterfowl begin to lose their typical habitats as a result of shallowing and drying out of shallow lakes and swampy meadows. In this regard, the dynamics of their habitats is very complex. Simultaneously with the shift of their ranges to the north, they have a tendency to move towards the east or west. It should be noted that the ranges of all species of migratory birds have advanced to the north, since droughts and low-water periods were characteristic, first of all, for the southern regions of Inner Asia. In many ways, this is determined by the location of the most optimal habitats preferred by different bird species.

In the group of migratory birds under consideration, four ecological groups of species are distinguished. Undoubtedly, the most numerous group are near–water and waterfowl bird species - 55.0% (Table 2). They also prevail in numbers. Among them, even at the first stages of evictions, quite numerous species are often noted: reed warbler *Gallinula chloropus*, Marsh Sandpiper *Tringa stagnatilis*, White-winged Black Tern *Chlidonias leucopterus*, Kittiwake *Rissa tridactyla,* Oriental Reed Warbler *Acrocephalus orientalis*. It should be noted that the first wave of bird evictions is always formed by birds of swampy meadows and shallow waters [26-27, 31-32]. And this is quite understandable, these habitats disappear first of all, since warming is usually associated with the development of severe and extensive droughts or the establishment of long periods of low water [25-27, 31-32]. It is this circumstance that causes waves of mass migrations of individual species, since birds of these habitats, usually differ in high local numbers.

Table 2. Reactions of birds of different ecological groups to the initial stages of climate warming (the end of the XIX - the first half of the XX centuries).

Ecological a group of birds	Number species	The area is torn apart		The direction of bird evictions			
		yes	no	to east	to west	to north	stay
Shorebirds and Waterfowl	33	7	26	9	10	3	11
Birds of prey	10	2	8	6	1	3	-
Forest birds	12	-	12	7	5	-	-
Meadow birds	5	-	5	3	1	-	1
Total	60	9	51	25	17	6	12

Source: compiled by the author

The number of birds of prey and forest birds that have changed their distribution over the territory is approximately the same, and only a few of them have broken ranges (Table 2). In addition, some birds of prey belong to forest species, and many of them, even in the case of preferential development of open landscapes, arrange nests on the edges of forests. Obviously, changes in the ranges and abundance of birds of prey are associated with the number of their victims. The eviction of the main and most widespread bird species to the north dramatically reduces the number of available feeding facilities. At the same time, weather factors are also important. The arid climate clearly worsens the habitat conditions of birds of this group of species. This fully applies to forest birds. Among them, there are species found in forests in large numbers only in wet years. Since many of them are very numerous, the overall abundance of birds is definitely decreasing during dry and low-water periods.

The smallest number of migratory species was recorded in the group of meadow birds (Table 2). The poorer species composition of meadow birds (with the exception of wet meadows) was also pointed out by B.K. Stegman [11] when describing the bird population of the zonal steppes. Obviously, this factor is caused by a small variety of habitats in steppe and desert zones and, in addition, is associated with their high aridity. The general, rather high species diversity of birds in such areas of a large area is associated with the presence of intrazonal habitats of a small area (forest clearings, rocky outcrops, lakes, swamps, etc.). Probably, the lower dependence of birds in arid areas on their moisture level is the reason for the low number of their registrations among birds that began to settle already with very little climate warming.

Birds that are beginning to be the first to respond to climate warming include a relatively small number of species with broken ranges (Table 2). Basically, such ranges are typical for near-water and waterfowl, which use intrazonal habitats for nesting, found in all natural zones and mountain belts [26, 32, 46]. In this regard, they easily find suitable habitats in any conditions, but their spatial structure is very dynamic. Forest and, especially, meadow and steppe species react to the desiccation of the territory in the last place. This is especially typical for desert species (with the exception of a group of coastal birds) – they react to a sharp warming of the climate in the last place [26-27, 32].

The direction of evictions is another important issue in studying the dynamics of bird ranges. At the initial stages of the modern eviction of birds from their original ranges, the flow of migrants settling to the east clearly prevailed (41.7%). At the same time, a fairly significant group of birds that are classified as migratory species are not. Due to the lack of suitable habitats for a rest stop or low numbers they fly through Eastern Siberia without stopping. In essence, the registrations of such bird species are random, although their total share is quite high – 20.0%. Species with extensive southern ranges are clearly characterized by settlement only to the north, but their total share is clearly small – only 10.0%. At the first stage of climate warming, the flow of birds settling to the west is noticeably inferior in terms of the number of species – 28.0%, to the flow of birds moving to the east (41.7%), but it is more powerful.

4 Discussion

Despite the long history of studying the bird fauna of Eastern Siberia, it was pretty hard to imagine its full characteristics at the first stages of research. Nevertheless, large survey works carried out at this time allow for a full-fledged analysis of its condition and provide a list of the species composition of birds throughout the region [5-8, 10-14, 16, 20]. The preparation of a multi-volume publication covering the entire period of bird research in Russia and the USSR greatly facilitated further work with available materials [33]. And finally, the publication of a complete list of birds of Eastern Siberia made it possible to conduct special analyses of the state of their fauna in the initial period of already quite pronounced climate warming [21-24, 29].

A full-fledged review of climatic situations in the XX century, was made by I.V. Koshelenko [46]. An undoubted connection between these processes and changes in solar activity has been revealed [47-48]. In addition, its increase at the beginning of the 20th century (1910-1940) coincides with the change in the latitudinal direction of air mass transfer to the meridional transfer (North Atlantic sector). It should be noted that a series of dry periods gradually shifting to the east, covered the southern regions of Eurasia [46]. Therefore, the warming of the temperate latitudes of Eastern Europe and Siberia, which was determined by the impact of the northern outskirts of the regions affected by droughts, was gradual and insignificant. In during this period, a western stream of migratory birds formed, gradually moving towards the east.

The same flow, acting in the opposite direction (birds moved west), formed in the east of Eurasia (Pacific sector). Here the latitudinal transfer of air masses (monsoons) also changed to a meridional transfer. In the first half of the 20th century, this stream was clearly weaker than the western one and was noticeably inferior to it in terms of the number of evicted species (17 and 25). By this time, the north-western transport of air masses, very characteristic of the Pre-Baikal region, had significantly weakened [26-27, 49] and the contact zone of air masses of the western and eastern directions (the Siberian frontal zone) had gone far north (to the level of Southern Yakutia). As a result, an extensive hotbed of elevated temperatures of the surface air layer has formed in Eastern Siberia. Here, the average climate warming at this time was 1.9°C/100 years, compared with 0.7°C/100 years for the entire Northern hemisphere of the Earth [26-27, 50]. In its most vivid form, this phenomenon was characteristic of the Trans-Baikal natural territory, located in the rain shadow [35].

The uniqueness of the current climate situation lies in the fact that Eastern Siberia became the scene of restructuring of the bird fauna earlier than other regions. The Baikal rift zone, which is the Baikal zoogeographic boundary in the distribution of birds and mammals of Eastern Siberia, has made significant adjustments to the distribution of birds [51]. Of the 60 species to date, 19 (31.7%), as well as migratory birds (20.0%), have not changed their status. 6 species [10.0%] received the status of common breeding birds. Small nesting species include 22 species [36.7%]. For one species (1.7%), the status has been clarified and is now an alien species, appearing in seasons with very strong storm winds. The comparison of the obtained frequencies of species distributions by meeting categories in the first half of the 20th century and in the modern period was carried out on the basis of the Kolmogorov-Smirnov uniformity criterion. It is the most rigorous in solving problems of this type [40]. The difference between the frequency of meetings during these periods is significant - $D_{5(0.05)} = 18/60$. Consequently, it is the migratory species that well reflect the response of birds to long-term and unidirectional climate changes. In such cases, the eviction of birds for many species ends with their naturalization and the development of new areas of plots.

5 Conclusions

The initial increased aridity of Transbaikalia sharply distinguishes it from the general system of regions of the northern hemisphere of the Earth. Here, the processes of change in natural ecosystems under the influence of general climate warming took place earlier and at a higher rate. During the period of maximum warming, Cisbaikalia also joined this territory. This makes it possible to quickly identify in Eastern Siberia the features of the development of natural processes at the initial stages of their strong transformations. Considering the features of the modern geological epoch in the history of the Earth (the modern Holocene interstadial), a detailed analysis of such changes is of paramount importance. Undoubtedly, the benchmarks for the initial processes of bird eviction into adjacent territories in conditions of sharp climate warming are mass arrivals of birds atypical for the region. However, in these situations, massive and most noticeable evictions are primarily characteristic of semi-aquatic and waterfowl that use wet meadows and shallow waters for nesting - intrazonal habitats found in all natural zones and mountain belts. Real clarification of the status of migratory birds is possible only with long-term unidirectional trends in changing climate situations.

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