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Changes in the Fauna and Distribution of Birds of the Forest-Steppe Trans-Urals in the Late 20th to Early 21st Centuries Under the Influence of Natural and Anthropogenic Factors

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Abstract—The distribution of birds in the West Siberian plain in the western part of the forest-steppe zone (bound east by the Ishim River) is very dynamic. Just since the beginning of this century, 17 new breeding species have been discovered in this region. Most of them (76%) are representatives of the Tropical group (five species) dispersing from the south, as well as the Nomadic (5) and the European (3) types of fauna coming from the south and the west; three species belong to the Chinese type of fauna and one belongs to the Siberian type. Another new species from the Tropical group was recorded as breeding in the last decade of the previous century. The distribution ranges of all six representatives of the Tropical group and two species of the Nomadic fauna associated with aquatic habitats have expanded northward most over the past 40 years (for 500–600 km). A powerful wave of their dispersal in the forest-steppe occurred during the years of maximum filling of water reservoirs in the early 2000s. At the same time, despite the cyclical dynamics of the water level, cyclical processes in the changes of the distribution of limnophile birds are not expressed (analysis of century-long faunal lists shows the cyclical nature of the distribution of no more than 2–3 such species). It is assumed that against the background of intense climate warming most bird species, primarily limnophiles, are not simply redistributing individuals within the ranges, but are expanding their ranges northward, and that expansion will continue in the future. The anthropogenic impact on the regional avifauna is mainly caused by the consequences of the economic crisis in agriculture. In recent decades, it has been much less obvious than the natural impact.

Keywords: hydrological cycles, global warming, nesting, range boundaries, fauna dynamics, distribution
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INTRODUCTION

Birds, due to their high mobility, are able to respond quickly to changes in living conditions, which is manifested in changes in the boundaries of their distribution ranges and numbers. The state of local populations of many species, including massive ones, is highly unstable. Changes in bird distribution and abundance are often global in nature, and to understand their causes it is necessary to combine and analyze data from different regions.

The Southern Trans-Urals, like many other regions in our country, has recently undergone a large-scale and profound transformation of natural landscapes, which has greatly changed the living conditions of birds. In addition to economic activity, these conditions were also influenced by natural factors such as climatic and related hydrological factors. Changes in natural conditions cause a reduction in the area of habitats, the disappearance of some species and an increase in the abundance and dispersal of others. These processes are subject to general patterns, the understanding of which makes it possible to predict further changes in the regional avifauna.

The first analysis of changes in the avifauna of the Southern Trans-Urals that occurred during the 20th century was conducted by T.K. Blinova and V.N. Blinov [1], who dedicated a separate section in their monograph to its results. These researchers in 1982–1986 studied in detail the fauna and bird population of the Tobol forest-steppe and the Tobol-Ubagan steppe, and used the faunal lists of P.P. Sushkin [2], V.F. Larionov [3], I.M. and P.M. Zalesskikh [4], N.A. Olshvang [5], S.S. Schwartz et al. [6], and V.I. Azarov [7] to analyze the changes, as well as information on individual species from other publications. The authors concluded that by the mid-1980s, 33 bird species had clearly stopped nesting in the Trans-Urals forest-steppe, while of the new species, only the Bearded Tit *Panurus biarmicus* (L.) had appeared in nesting areas.

The previous review [8] examined the dynamics of the regional avifauna in the period from the mid-20th century to the first decade of the 21st century. In this

paper, the main attention is paid to the analysis of the reasons for the changes that occurred in the fauna of birds of the Southern Trans-Urals over the past four decades, which have passed since the research of T.K. Blinova and V.N. Blinov, taking into account the new data obtained in 2010–2020s.

METHODS AND MATERIALS

In this work, the term "Trans-Urals forest-steppe" refers to the territory of the forest-steppe zone adjacent to the Trans-Ural peneplain of the West Siberian Plain, to the east, to the valley of the Ishim River. The region under consideration extends approximately 300 km from north to south and 500 km from west to east.

The analysis of the most important trends in the transformation of the regional avifauna is based on a comparison of faunistic lists from the late 20th and early 21st centuries. This temporal division of the species composition of birds at the turn of the century is largely artificial, since many of the phenomena considered in the work began to occur in the 1990s and even earlier, but it is not possible to compile complete lists for each past decade. At the end of the 20th century, the fauna and bird population of the Trans-Urals forest-steppe were most fully studied by T.K. Blinova and V.N. Blinov [1, 9], who in 1982–1984 recorded 224 species here and received direct or indirect indications of nesting for 145 of them. Their materials supplement the information of other authors for the 1970s–1990s [10–25 and others]. The total list of birds in the region at the end of the 20th century consisted of 267 species, of which 199 were classified as nesting or presumably nesting.

The author's own research began in the Kurgan oblast in 1996–1999 with short trips to the vicinity of the villages of Lyubimovo, Peschano-Koledino, and the village of Maly Atyazh in the Dalmatovo district, as well as the village of Ulugushskoye in the Kataysk district. The first full field season devoted to the study of the nesting bird population was conducted in May–June 2000 in the vicinity of Lake Manyass in the Vargashy district. In all subsequent years, the author carried out semi-stationary studies lasting from several days to two months in various areas of the Kurgan and adjacent forest-steppe regions of the Chelyabinsk, Sverdlovsk, Tyumen, Kostanay, and North Kazakhstan oblasts at the height of the nesting season: usually from the end of April or the beginning of May until the end of June. To identify seasonal aspects of the regional avifauna, the timing of the work in some years covered the periods of spring (March–April) and autumn (July–October) bird migration. The total number of observation days in 2000–2023 was 1159.

The author most fully surveyed the territory of the Kurgan oblast. The research covered all 24 administrative districts of the oblast to varying degrees of completeness. In certain key areas, work was carried out with varying frequency over several seasons. Thus, in the Kurgan oblast in 1999–2010, observations were carried out annually in the vicinity of the villages of Lyubimovo and Peschano-Koledino, the Dalmatovo district; in 1996, 2005, 2015, 2020—in the vicinity of the village of Maly Atyazh of the same district; in 1998, 2011, 2015, 2017—in the vicinity of the village of Ulugushskoye, the Kataysk district; in 2000–2002, 2011–2012, 2017, 2022—in the vicinity of Lake. Manyass, the Vargashy district; in 2001–2002 and 2015—in the vicinity of Makushino; in 2002, 2008, 2011, 2013–2014, 2017–2018—in the vicinity of Trud i Znanie village, the Zverinogolovskoye district; in 2002, 2013, 2022—in the vicinity of Lake Malye Donki, the Kurtamysh district; in 2003–2004—in the vicinity of the Lake Bykovo, the Chastoozerskoye district; in 2003 and 2011—in the vicinity of Lake Chernoye, the Mokrousovo district; in 2009, 2011–2012—in a number of places in the Safakulevo and Almenevo districts. In the Chelyabinsk oblast, the surroundings of the Bolshoye Irkabayevo village (the Kunashak district) were surveyed, in 2006 and then again in 2018, in the Tyumen oblast – the vicinity of Lake Bolshoe Beloe, the Armizonskoye district in 2012 and then in 2015.

To analyze the long-term dynamics of the water level of the territory, series of average annual depth assessments of three model reservoirs were used: lakes Argayash, Almenkol, and Maloye Butyrino. The first is located in the northwestern part of the region under consideration, in the Argayash district of the Chelyabinsk oblast (northern forest-steppe), the second is in the southwestern part, in the Almenevo district of the Kurgan oblast (southern forest-steppe), the third is in the northeastern part, in the Chastoozerskoye district of the Kurgan oblast (northern forest-steppe), the distance between the outermost lakes is 450 km. Data on their filling level were provided by the Sverdlovsk Center for Hydrometeorology and Environmental Monitoring.

METHODS AND MATERIALS

The main efforts during field work were focused on obtaining evidence of nesting of certain species (primarily rare and poorly studied ones), for which I took the presence of nests with clutches and broods with flightless or poorly flying chicks. I also considered the dynamics of their numbers to be an important indicator of the state of species. Most often, I limited myself to a visual assessment of the relative abundance of species on a 5-point scale and took it into account when a species clearly transitioned from one category to another (for example, it was "rare" and became "common"). In most cases, this was sufficient to identify trends in long-term abundance dynamics. Additionally, in certain key areas (primarily in those where T.K. Blinova and V.N. Blinov previously worked) I carried out quantitative counts of nesting birds using

the method of mapping mating pairs on test sites (in total about 1.5 thousand km^2). The sites for recording the most common and numerous birds were separate homogeneous areas with clearly defined outlines on the terrain: forests, meadows, lakes, swamps, floodplains, etc. I calculated their sizes using freely available space images. I counted rare birds (cranes, pigeons, owls, cuckoos, etc.) over large areas using sound direction finding, and birds of prey, by mapping nesting areas. In vast homogeneous areas (fields, fallow lands, forests), I conducted route counts of birds without limiting the width of the counting strip, as well as point counts on circular sites. Complete quantitative censuses of the entire nesting bird population were carried out over the course of 12 field seasons in cases where work in one key area lasted at least 14–15 days.

I carried out expedition trips both alone and together with colleagues and students. We worked in one or two groups on vehicles; a field team usually consisted of 2–3 people (up to 6 in 2002 and 7 in 2003). Many colleagues (V.K. Ryabitsev, I.V. Primak, A.V. Gashek, A.A. Kuzmich, V.E. Polyakov, I.O. Bologov, S.E. Zvigintsev, and A.Yu. Davydov) also independently published their observations, which are also used in this review. In total, over 150 works on the avifauna of the Trans-Urals forest-steppe were published from 2000 to 2023, of which about 100 were the author's works. Listing them in the bibliography would take up a lot of space, so references to these sources are mostly not provided. Of the 53 bird species discovered in the regional avifauna for the first time in the last 20 years or noted as nesting compared to the same previous period (Table 1), I personally, including during joint trips with colleagues, found 21.

Zoogeographical analysis of the regional avifauna is based on the classification proposed by V.P. Belik [26–28]. The names of species, as well as the order in which they are listed, correspond to the "List of birds..." [29].

RESULTS AND DISCUSSION

Changes in Species Composition and Nature of Stay

Since 2000, 302 bird species have been recorded in the region under consideration, direct or indirect evidence of nesting has been obtained for 217 of them, 60 have been recorded during migration and wintering, and another 25 are classified as migratory. Changes in the nature of stay or abundance affected about 90 bird species, or 30% of their total number. The number of new species compared to the 1970–1990s was 46, and for another 5 species, previously considered migratory or vagrant, evidence of nesting was obtained, and for 2 species, there was reason to assume nesting (Table 1).

About half of those indicated in Table 1 as "new" species (21) were rediscovered after at least half a century of absence. These are mostly extremely rare birds, some of which may have been missed by researchers at the end of the last century. With some certainty, we can speak about the reappearance, obviously connected with the pulsation of habitats, of three species (Red-crested Pochard, Demoiselle Crane, Little Bustard), nesting in significant numbers both until the middle of the 20th century and at present. The Ferruginous Duck was also quite common in the past (on the lakes of the southern Tyumen oblast it was second in numbers only to the Common Pochard *Aythya ferina* (L.) and Velvet Scoter *Melanitta fusca* (L.) [10], but it is difficult to say whether it was really absent for the entire second half of the last century, since even at present its registrations are extremely rare and are confined mainly to the autumn period.

The distribution of 17 new nesting and presumably nesting species (including 6 species that were considered migratory or vagrant until the mid-20th century) by fauna types shows that 5 of them belong to the tropical group and the same number to the nomadic type, 3 each to the European and Chinese types, and 1 to the Siberian type. The five migratory species discovered for the first time are predominantly Siberian (4) and one is Arctic, which may indicate a clarification of their migration routes or an accumulation of facts of deviation from these routes. Another 3 migratory species are representatives of the Among the 9 newly discovered vagrant species, there are representatives of the tropical group (3), European, Arctic (2 each), and the Siberian (1) types of fauna and one is of unclear origin.

If we consider a shorter period of time, only the last four decades, we notice the emergence in the 21st century in the regional breeding avifauna of primarily representatives of the nomadic type of fauna and the tropical group of species settling from the south (Table 2). Many of them now nest much further (up to 500 km) than the previously known boundaries of their ranges. So, the Great Egret, Kentish Plover, Gull-billed Tern, Caspian Tern, European Bee-eater, and Cetti's Warbler were widespread in the 1980s in Kazakhstan as far north as the 51st parallel [30]. At the same latitude, the Great White Pelican nested on the lakes of the Naurzum Nature Reserve [31]. In the 2000s, nesting colonies of the Great Egret were discovered in the Oktyabrskoye district of the Chelyabinsk oblast; Zverinogolovskoye, Ketovo, and Mokrousovo in the Kurgan oblast; Armizonskoye, Berdyuzhye, and Kazanskoye in the Tyumen oblast; and in several other areas, summer encounters of likely nesting individuals were noted. This indicates a wide distribution of this species throughout the forest-steppe, including its northern subzone. In 1997 and 1998, the Great White Pelican was already breeding on the southern border of the forest-steppe in the north of the Kostanay oblast [31], and in 2012, in the vicinity of the city of Kurgan, another 150 km to the north. Colonies of the Gull-billed Tern were discovered in 2009 in the Kurtamysh and

Table 1. List of the bird species registered as breeding or recorded in the Trans-Urals forest-steppe for the first time since the end of the 20th century

Species	End of the 20th century	21st century
White-billed Diver *Gavia adamsii* (G.R. Gray, 1859)		s.v.
Great White Pelican *Pelecanus onocrotalus* L.		n
Black-crowned Night Heron *Nycticorax nycticorax* (L.)		v
Great Egret *Casmerodius albus* (L.)*	v	n
Glossy Ibis *Plegadis falcinellus* (Linnaeus, 1766)		s.v.
Black Stork *Ciconia nigra* (L.)*		s.m.
Brent Goose *Branta bernicla* (L.)*		m
Baikal Teal *Anas formosa* Georgi, 1775		v
Red-crested Pochard *Netta rufina* (Pallas, 1773)**		n
Ferruginous Duck *Aythya nyroca* (Güldenstädt, 1770)**		n?
Common Eider *Somateria mollissima* (L.)		s.v.
Black Scoter *Melanitta nigra* (L.)*		m
Long-legged Buzzard *Buteo rufinus* (Cretzschmar, 1829)*		v
Short-toed Snake-eagle *Circaetus gallicus* (J.F. Gmelin, 1788)		v
Booted Eagle *Hieraaetus pennatus* (J.F. Gmelin, 1788)		v
Siberian Crane *Grus leucogeranus* Pallas, 1773**		m
Demoiselle Crane *Anthropoides virgo* (L.)**		n
Great Bustard *Otis tarda* L.**		v
Little Bustard *Tetrax tetrax* (L.)**		n
Eurasian Golden-plover *Pluvialis apricaria* (L.)*		m
Kentish Plover *Charadrius alexandrinus* L.		n
Ruddy Turnstone *Arenaria interpres* (L.)*		m
Broad-billed Sandpiper *Limicola falcinellus* (Pontoppidan, 1763)		m
Eurasian Curlew *Numenius arquata* (L.)**	m	n
Whimbrel *Numenius phaeopus* (L.)**	m	n
Asian Dowitcher *Limnodromus semipalmatus* (Blyth, 1848)**	v	n?
Great Black-headed Gull *Larus ichthyaetus* Pallas, 1773*		n
Gull-billed Tern *Gelochelidon nilotica* (J.F. Gmelin, 1789)		n
Caspian Tern *Hydroprogne caspia* (Pallas, 1770)		n
Tengmalm's Owl *Aegolius funereus* (L.)*		n
Little Owl *Athene noctua* (Scopoli, 1769)		n
European Bee-eater *Merops persicus* Pallas, 1773		n
White-winged Lark *Melanocorypha leucoptera* (Pallas, 1811)**	s.v.	s.n?
Wood Lark *Lullula arborea* (L.)		n
Richard's Pipit *Anthus richardi* Vieillot, 1818		n
Olive-backed Pipit *Anthus hodgsoni* Richmond, 1907*	m	n
Grey Wagtail *Motacilla cinerea* Tunstall, 1771*	v	n
Lesser Grey Shrike *Lanius minor* J.F. Gmelin, 1788**		s.v.
White-throated Dipper *Cinclus cinclus* (L.)		s.w
Black-throated Accentor *Prunella atrogularis* (J.F. Brandt, 1843)		s.m.
Cetti's Warbler *Cettia cetti* (Temminck, 1820)		n
Aquatic Warbler *Acrocephalus paludicola* (Vieillot, 1817)		s.v.
Yellow-browed Warbler *Phylloscopus inornatus* (Blyth, 1842)		m
Taiga Flycatcher *Ficedula* (*parva*) *albicilla* (Pallas, 1811)		s.m.
Isabelline Wheatear *Oenanthe isabellina* (Temminck, 1829)*		v
Black Redstart *Phoenicurus ochruros* (S.G. Gmelin, 1774)		n
Common Nightingale *Luscinia megarhynchos* C.L. Brehm, 1831		s.v.
Siberian Rubythroat *Luscinia calliope* (Pallas, 1776)		m
Northern Red-flanked Bluetail *Tarsiger cyanurus* (Pallas, 1773)*		m
Black-throated Thrush *Turdus atrogularis* Jarocki, 1819**		s.v.
Common Blackbird *Turdus merula* L.		n
Long-tailed Rosefinch *Uragus sibiricus* (Pallas, 1773)*		n
Pine Grosbeak *Pinicola enucleator* (L.)*		w

Status: n—nesting, n?—probably nesting, m—migrant, v—vagrant, w—wintering; s—single record; *—recorded at the beginning to middle of the 20th century as a migrant, wandering or vagrant; **—recorded as a nesting.

Table 2. Zoogeographic composition of the new (compared to the end of the 20th century) species of the avifauna of the Trans-Urals forest-steppe

Faunogenetic groups	Status					Total
	n	n?	m	v	w	
Arctic type of fauna	1		5	2		8
Siberian type of fauna	1		6	2	1	10
European type of fauna	4			4	1	9
European-Chinese type of fauna			1			1
Chinese type of fauna	3	1				4
Nomadic type of fauna	8	2		3		13
Tropical group of species	5			3		8
Total	22	3	12	14	2	53

Status: n—nesting, n?—probably nesting, m—migrant, v—vagrant, w—wintering.

Makushino districts of the Kurgan oblast (southern forest-steppe).

The Kentish Plover was recorded in 2001 as a nesting species in the Chastoozerskoye (northern forest-steppe) district and 2007 in the Lebyazhye (southern forest-steppe) district of the Kurgan oblast. The Caspian Tern was discovered (with presumption of nesting) in 2007 in the south of the Tyumen oblast; in the subsequent years, several more birds were recorded during the nesting season in a number of places in the Tyumen and Kurgan oblasts, and in 2022, nesting of the species here was confirmed. The European Bee-eater and Cetti's Warbler have become common nesting species in the southern forest-steppe, north to the latitude of Chelyabinsk and Kurgan. It should be noted that the latter clearly tends towards river valleys with dense willow thickets, and it was along such valleys that its settlement mainly took place. It is assumed that from the left tributaries of the Urals, the Cetti's Warbler, having passed narrow watersheds, entered the left tributaries of the Tobol River and then penetrated the valley of the Tobol River itself, while bypassing its sources [32]. It clearly avoids interfluve spaces, although they are not an insurmountable obstacle to its settlement [33].

In the middle of the last century, the Red-crested Pochard nested to the north up to the latitude of the city of Kurgan [6], but later disappeared from the forest-steppe zone. In the steppes of Northern Kazakhstan in the 1980s it was common and even numerous in some places, then it was not recorded until the beginning of the 1990s [34]. Over the past three decades, the range of this species has expanded significantly to the north; it has not only returned to the forest-steppe zone, but has also populated almost all of it, and in a number of areas (Mokrousovo, Armizonskoye) it has become numerous. The increase in the number of this duck contrasts with the steady decline of other duck species and may be related to its ability to feed on the abundant elodea in the lakes, *Elodea canadensis* Michx. (1803), which other ducks do not use [35].

In addition to those specified in Table 1, the Black-winged Stilt *Himantopus himantopus* (L.) (tropical group of species) should be added, first recorded as nesting in the region a little earlier, in the 1990s, but it was in the 2000s that it began to develop intensively its territory, having populated it almost completely by now. The distribution area of this species in Kazakhstan was also limited to the 51st parallel [30], although in some years it was recorded further north [16]. In 1986, T.K. Blinova and V.N. Blinov [1] found it breeding throughout the steppe zone within the Turgai meridional depression, and in 1991–1998 its nesting sites were discovered in several areas of the Chelyabinsk and Tyumen oblasts [15, 18, 22, 23, 36]. In the 2000s–2010s, in most areas of the Kurgan oblast, I found it common, and in some places even numerous. Currently, the northernmost nesting sites of this species are located on the southern border of the forest zone, 600 km north of the previous ones.

The range of the Mute Swan *Cygnus olor* (J.F. Gmelin, 1789) has expanded significantly (nomadic type of fauna), which in the 1980s was widespread in the Trans-Urals to the north to the southern forest-steppe and now nests in the south of the forest zone. In the Urals, it has spread to the tundra zone: its broods have been recorded beyond the Arctic Circle, in the Pechora delta at the 68th parallel [37].

Simultaneously with the northward advance of several "southern" species, a distinct decrease in the frequency of encounters and numbers of some "northern" species is noted, which may indicate a shift in the same direction, into the forest zone, of the southern boundaries of their distribution ranges. Since the end of the last century, the Eurasian Wigeon *Anas penelope* L., Smew *Mergellus albellus* (L.), Osprey *Pandion haliaetus* (L.), Eurasian Merlin *Falco columbarius aesalon* (Tunstall, 1771), Wood Sandpiper *Tringa glareola* L., Common Greenshank *T. nebularia* (Gunnerus, 1767)

have not been nesting in the area. The nesting abundance of the Horned Grebe *Podiceps auritus* (L.) and Willow Ptarmigan *Lagopus lagopus* (L.) has sharply (several times) decreased. In the current century, only three cases of nesting of the Velvet Scoter have been recorded, whereas in the 1970s, in the forest-steppe regions of the Tyumen oblast alone, from 60 to 150 pairs nested [16]. The Northern Pintail *Anas acuta* L., Common Goldeneye *Bucephala clangula* (L.), Terek Sandpiper *Xenus cinereus* (Güldenstädt, 1775), Ruff *Philomachus pugnax* (L.), Great Snipe *Gallinago media* (Latham, 1787), Grey-headed Woodpecker *Picus canus* JF Gmelin, 1788, Great Gray Shrike *Lanius excubitor* L., and Yellow-breasted Bunting *Ocyris aureolus* (Pallas, 1773) have also virtually ceased nesting. This group is dominated by species of the Siberian (7) and Arctic (6) types of fauna, two species belong to the European, one to the Chinese, and two more are of unclear origin. The Velvet Scoter has in fact ceased to have a flight path through the region in question, and the same can be said for the Long-tailed Duck *Clangula hyemalis* (L.) and Eurasian Dotterel *Eudromys morinellus* (L.).

The rapid northward shift of the northern boundaries of the ranges of several southern species and the emerging shift in the same direction of the southern boundaries of the ranges of northern species coincided in time with the onset of intense climate change known as "global warming" (see below). It is noteworthy that most of the species listed above belong to the wetland complex. A similar trend is not observed among the southern inhabitants of open dry steppe spaces. The habitats of such species in the Southern Trans-Urals were disrupted as a result of virgin land development in the middle of the last century, after which the Saker Falcon *Falco cherrug* JE Gray, 1834, Demoiselle Crane, Great Bustard, Little Bustard, Sociable Lapwing *Chettusia gregaria* (Pallas, 1771), White-winged Lark, Lesser Gray Shrike, Rosy Starling *Pastor Roseus* (L.), and Pied Wheatear *Oenanthe pleschanka* (Lepechin, 1770) disappeared from the territory in question, retreating into the steppe zone. All these species are representatives of the nomadic type of fauna, except for the Lesser Grey Shrike (European). Of these, only the Demoiselle Crane and Little Bustard were later able to adapt to nesting in agrocenoses and partially restored their former nesting areas, becoming quite common to the north up to the latitude of Chelyabinsk and Kurgan. The other listed species (except for the Rosy Starling and Pied Wheatear) continue to occasionally fly into the forest-steppe, but there are no reliable facts about their nesting.

Nesting finds in the Trans-Urals forest-steppe allow us to push the previously known distribution boundaries of two more species not associated with aquatic habitats far to the north: the Little Owl and Eurasian Collared-dove *Streptopelia decaocto* (Frivaldszky, 1838). Thus, until the last quarter of the 20th century, the nearest breeding sites of the Eurasian Collared-dove were known in Turkmenistan; by the mid-1970s, it had colonized most of Europe; by the early 1990s, it was registered as a nesting species in Bashkiria and in the south of the Chelyabinsk oblast [38], and in the 2000–2010s, in the southern and central regions of the Kurgan oblast and in the south of the Sverdlovsk oblast. However, in this case, the dispersal of the species could have gone not from south to north, but from west to east, from the Urals as, probably, did the Little Owl. All Little Owl finds within the region under consideration are associated with human constructions, which is why I believe that birds of a non-desert subspecies appeared in the Trans-Urals forest-steppe *bactrian*, which are known [39] to avoid cultural landscapes and human structures, and the European (nominative) subspecies *noctua*, who, on the contrary, prefer them.

It should be noted that since the end of the 20th century, nesting of some other species of owls has been recorded in the forest-steppe zone of the Trans-Urals: the Northern Hawk Owl *Surnia ulula* (L.), Ural Owl *Strix uralensis* Pallas, 1771, Great Grey Owl *S. nebulosa* JR Forster, 1772 [19–21], and since the beginning of the current century, the Tengmalm's Owl. Apparently, these Siberian species have recently spread into the forest-steppe from the forest zone. Moreover, the Ural Owl and the Great Grey Owl have already spread widely throughout the region, and the latter in some years reaches very high numbers. Other bird species showing examples of southward range expansion include the Olive-backed Pipit, Grey Wagtail, Lanceolated Warbler *Locustella lanceolata* (Temminck, 1840), and European Robin *Erithacus rubecula* (L.). Their main area of distribution also extends to the north of the region in question, and the first two species are still extremely rare here, while the last two appeared a little earlier and are now found noticeably more often.

The Eurasian Wren penetrated into the Trans-Urals from the west in the last decade of the 20th century. These include *Troglodytes troglodytes* (L.), Dunnock *Prunella modularis* (L.), Blue Tit *Parus caeruleus* L. [12, 19, 21] 1999), and even earlier, European Greenfinch *Chloris chloris* (L.) [11], and the rapid expansion of the last two species to the east continued, and the Blue Tit has now reached the Irtysh River, and the European Greenfinch has reached Lake Baikal. And already in the 21st century, the Wood Lark, Black Redstart, and Common Blackbird have appeared to nest. Almost all of these species belong to the European type of fauna, except for the Eurasian Wren (Euro-Chinese) and the Black Redstart (Nomadic).

In the opposite direction, from the east, to the Urals, representatives of the Chinese type of fauna spread: the Richard's Pipit and Long-tailed Rosefinch, the second even further, into the European part of Russia [40]. Periodically, the range of the Asian

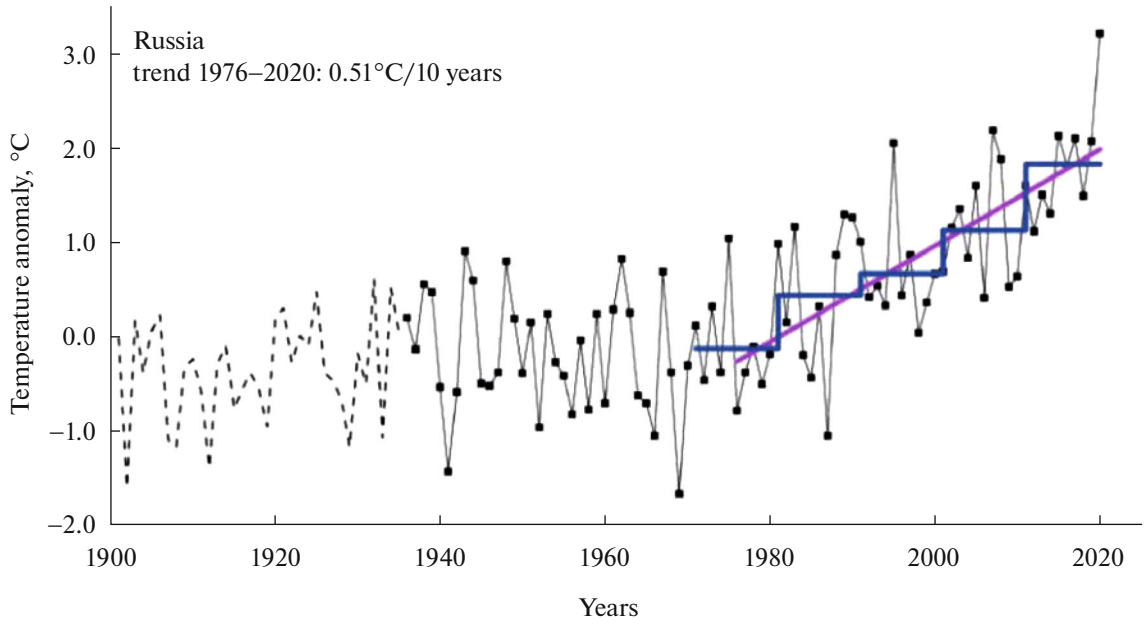

Fig. 1. Average annual deviations from the average temperature for 1961–1990 on the territory of Russia in the period from the beginning of the 20th century (before 1936 – dotted line due to lack of data); average values for five decades; linear trend for 1976–2020 [source: 41].

Dowitcher expands (pulsates) to the west to the Trans-Urals. At the same time, the narrowing of the range in the western direction leads to the disappearance of the Little Tern *Sterna albifrons* Pallas, 1764 and Tawny Owl *Strix aluco* L. from the region, whose nesting has been recorded since the end of the 20th century only to the west of the Urals. The same trend is observed with the European Turtle-dove *Streptopelia turtur* (L.), which has been in a state of deep depression in the region since the late 1990s [24], and there have been no records of its nesting since 2004.

Thus, it is clear that the expansion of species occurs in a variety of directions: from west to east, from east to west, from north to south, but the main movement of ranges now naturally goes from south to north. In the fauna of nesting birds of the Trans-Urals forest-steppe, the participation of species of the tropical, nomadic, and European types of fauna increases, and that of the Siberian and Arctic ones decreases. Representatives of the tropical group of species have advanced most northward. Moreover, if we do not take into account the Eurasian Collared-dove and Little Owl, which probably entered the region from the west, as well as the Demoiselle Crane and Little Bustard, which are restoring their former ranges, the northern vector of dispersal is demonstrated only by limnophilic species.

Climatic and Hydrological Factors

The increase in the proportion of southern species in the regional avifauna, with the simultaneous disappearance of a number of northern species, against the backdrop of global warming, seems entirely expected. In Russia, the most intense warming has been observed since the mid-1970s. The average annual temperature has increased by more than 2.5°C over the past half century [41], and the 2010s were not only record-breakingly warm, but the increase in average temperature over this decade was higher than in any of the previous decades (Fig. 1). This suggests that the rate of warming is increasing. In Western Siberia, the temperature increase, as on average in the country, is about 0.5°C per 10 years, while in the spring season it increases significantly faster than the annual average, at a rate of 0.8°C per 10 years. Undoubtedly, it is the spring temperature that has the greatest influence on the dispersal of birds compared to the temperature in other seasons of the year, since it determines the timing of the appearance of the necessary conditions for nesting. In addition, instrumental from meteorological stations in the Kurgan oblast show a reduction in the duration of the snow period over the several past decades, as well as a shift to earlier dates of the last spring frost [8], which indicates an extension of the frost-free period of the year. This allows birds to start the breeding season earlier and end it later, which may be important primarily for the southern species.

It is noteworthy that the powerful wave of introduction of southern species into the forest-steppe that occurred in the early 2000s occurred during the years of maximum water filling. The water level in the region under consideration is subject to rather complex fluctuations, in which approximately 10-year cycles can be

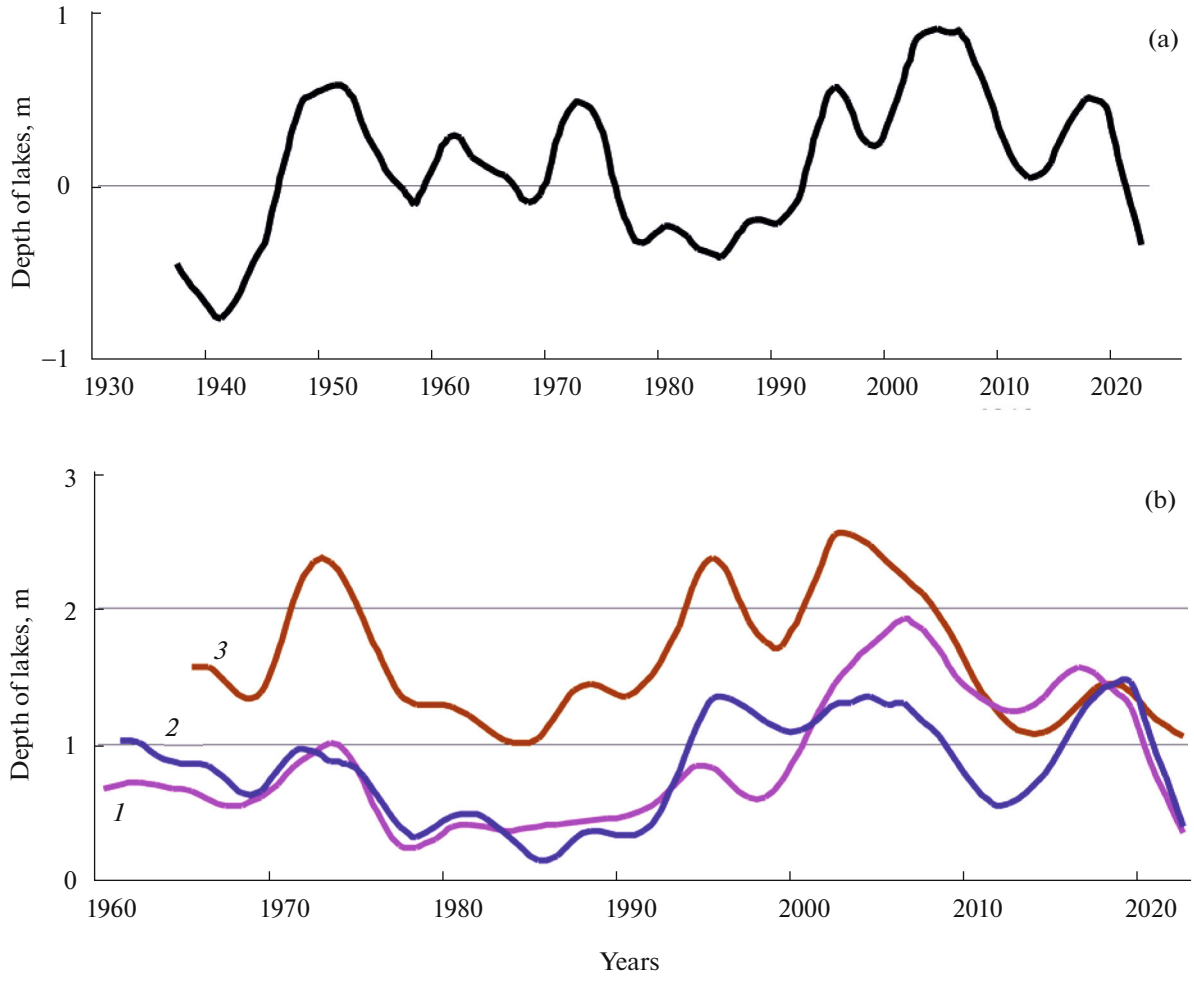

Fig. 2. Fluctuations in the level of lakes in the Trans–Urals forest-steppe (3-year moving averages): (a) – deviations from the average value; (b) – dynamics of filling of Lakes Argayash (*1*), Maloe Butyrino (*2*), Almenkol (*3*).

seen (Fig. 2a), with longer cycles of varying periodicity superimposed on them. At the same time, lakes located in the southern and northern forest-steppe, at a considerable distance from each other, show generally synchronous dynamics (Fig. 2b). The minimum level of filling of reservoirs in the Trans-Urals forest-steppe was observed in the early 1940s and then in the mid-1980s, just at the time when T.K. Blinova and V.N. Blinov were working here. Over the next 20 years, by the mid-2000s, the water level rose by an average of 1.3 m and then began to decline again, returning to its current minimum levels. Thus, over the past century, the most significant shallowing of water bodies occurred approximately every 40 years. At the same time, unlike the minimum level, the regular intra-century cyclicity of the maximum water level is not observed, apparently due to the fact that during such periods water, having filled the lakes, spills over the lakeside meadows, turning them into grassy swamps. Historical satellite images from Google Earth clearly show that in the mid-1980s, small lakes turned into backwaters, and many sedge swamps and reed backwaters dried up completely. By the mid-2000s, the total area of lakes and swamps in certain areas of the terrain had increased by 40% [8], which undoubtedly created more favorable living conditions for waterbirds.

Also A.N. Formozov [42] drew attention to the fact that the dispersal of wetland bird species from the steppe zone to the forest-steppe zone occurs mainly during dry periods, when the water level in the steppe lakes is minimal. Fluctuations in water levels in the steppe and forest-steppe zones of Western Siberia usually coincide, but the amplitude of fluctuations in the level of steppe lakes is significantly higher than that of forest-steppe lakes. Steppe lakes fill up to a greater extent during the wet phases of the cycle and become shallower during the dry phases, until they dry out completely. In addition, abundant evaporation in the steppe zone, combined with low meltwater runoff, leads to the process of lake drying up starting 1–3 years earlier and lasting twice as long as in the forest-steppe,

this causes a redistribution of birds across habitats during dry periods [43].

Earlier, I [8] expressed the opinion that, apparently, due to the process of continuing global warming that began in the mid-1970s, such a strict cyclical distribution of birds across habitats was disrupted. Firstly, the appearance of new southern species in the forest-steppe coincided not with the dry period of the mid-1980s, but with the peak water level of the early 2000s, when the conditions for existence in the steppe and forest-steppe zones were equally favorable. Consequently, what took place was not a redistribution of birds within their habitats, but their expansion. In the dry 1980s, when, according to A.N. Formozova, there should have been an eviction of wetland bird species from the steppe zone, T.K. Blinova and V.N. Blinov managed to discover only one new nesting species in the Trans-Urals forest-steppe, the Bearded Tit.

Secondly, despite the fact that fluctuations in water levels are a cyclical process, similarly cyclical changes in the distribution of birds in the Southern Trans-Urals are not expressed. From the materials on the fauna of birds in the region, over the entire century-long history of research, a pulsation of ranges can only be traced for the Red-crested Pochard and Asian Dowitcher (see above). In the 2010s–2020s, the water level in the region began to decline, and the process of bird dispersal, according to my observations, clearly slowed down, but there was no reverse movement of the range boundaries of southern aquatic and near-aquatic species. On the contrary, species such as the Great Egret, Great White Pelican, Mute Swan, Red-crested Pochard, Black-winged Stilt, and European Bee-eater have been found nesting 100–150 km further north (as have singing male Cetti's Warbler).

With the onset of intense climate warming in the last quarter of the 20th century and the lengthening of the frost-free period of the year, most of the southern species probably found more favorable conditions in the northern parts of their ranges, which were also characterized by a relatively stable hydrological regime. During the dry phases of the water cycle, when many steppe reservoirs dried up, the redistribution of birds was obviously predominantly local in nature. The filling of lakes during the wet phases of the cycle against the background of warming created favorable conditions for birds both in the steppe and in the forest-steppe, and this contributed to an increase in their abundance in both zones and the further expansion of their ranges.

Evidence of displacement of birds from the steppe zone to the forest-steppe zone due to shallowing of lakes is available only for the Dalmatian Pelican *Pelecanus crispus* Bruch, 1832 [44, 45], and it is largely due to the extremely local distribution of its nesting colonies, although it is possible that such displacement may also affect other species. For example, the mass appearance of the Black-winged Stilt in the forest-steppe zone in the late 1990s could have been partly caused by the drying up of lakes in Northern Kazakhstan [46], when the water level in the forest-steppe was also at a local minimum, but still above average values (see Fig. 2). Perhaps, to some extent, this same circumstance explains the rather high number of some near-water predators observed in the forest-steppe in recent decades (the Black Whale *Milvus migrans* (Boddaert, 1783), Pallid Harrier *Circus macrourus* (SG Gmelin, 1771), White-tailed Sea-eagle *Haliaeetus albicilla* (L.)) and fish-eating (Black-throated Diver *Gavia arctica* (L.), Great Cormorant *Phalacrocorax carbo* (L.), and Steppe Gull *Larus heuglini* Bree, 1876) birds.

The extremely high variability of the natural environment in the steppe zone, when even neighboring lakes can be at different stages of filling, forces most aquatic and near-aquatic birds to constantly change their breeding sites, causing them to migrate over long distances [42], which ultimately determines the cyclical nature of the dynamics of their ranges and numbers. The habitat conditions of birds in the forest-steppe are more stable, which, as shown above, is expressed in a much lesser pulsation of their ranges. I believe that the changes occurring in the distribution of most bird species in the Trans-Urals forest-steppe will be irreversible in the foreseeable future. The reverse movement of the boundaries of their ranges to the south will probably begin with the onset of the next cool-humid era of the centuries-old climatic cycle [47]. Therefore, in the coming decades, we can expect the emergence of new southern wetland species in the south of Western Siberia, such as the Little Grebe *Tachybaptus ruficollis* (Pallas, 1764), Pygmy Cormorant *Phalacrocorax pygmyus* (Pallas, 1773), Squacco Heron *Ardeola ralloides* (Scopoli, 1769), Little Egret *Garzetta Egretta* (Linnaeus, 1766), Purple Heron *Ardea purpurea* Linnaeus, 1766, Eurasian Spoonbill *Platalea leucorodia* L., Greater Flamingo *Phoenicopterus roseus* Pallas, 1811, Caspian Plover *Charadrius asiaticus* Pallas, 1773, Collared Pratincole *Glareola pratincola* (Linnaeus, 1766), Slender-billed Gull *Larus genei* Brème, 1840, Whiskered Tern *Chlidonia hybrida* (Pallas, 1811), Eurasian Reed-warbler *Acrocephalus scirpaceus* (Hermann, 1804) and others. Some of them may begin to nest in the forest-steppe. Vagaries of some of these species (the Black-crowned Night Heron, Eurasian Spoonbill, Glossy Ibis *Plegadis falcinellus*, Greater Flamingo) are already registered in the region as a vagrant.

Anthropogenic Factors

In the middle of the last century, the most powerful human impact on the birds of the south of Western Siberia was the large-scale campaign to plow virgin and fallow lands, launched in the south of Western Siberia and in the north of Kazakhstan in 1954–1965. Natural forest-steppe and steppe landscapes were

replaced by agrocenoses. Almost all meadows suitable for agriculture were converted into crop fields, and the remaining unplowed areas were subject to degradation due to overgrazing. As a result of these transformations, many inhabitants of open dry spaces (see above) disappeared from the forest-steppe zone, although for some time they still found relatively favorable conditions for existence in semi-desert-type biotopes that arose in areas of intensive grazing in the steppes of the Southern Urals [48, 49]. Later, in the 1970s, extensive reclamation work to drain swamps was carried out in the forest-steppe zone, as a result of which the area of wetlands was reduced by almost half [1]. This has been one of the reasons for the decline in the numbers of Rails, Great Snipe, and other wading birds. The campaign to exterminate birds of prey in the 1950s also played a sharply negative role.

At the end of the 20th century, another large-scale change in bird habitats occurred. The economic crisis that erupted due to the socio-economic transformations following the collapse of the Soviet Union caused a deep decline in agricultural production. This has led to a significant reduction in livestock numbers and crop areas throughout the country. In the Kurgan oblast, according to the Department of Civil Defense, Environment, and Natural Resources [50], the area of cultivated arable land for one decade (from 1992 to 2003) decreased by 2.3 times. By the end of the 2000s, it had recovered somewhat and now stands at 53% of its previous level. Almost half of the arable fields have turned into fallow land. In the southern forest-steppe they were overgrown with weeds, while in the northern they were mostly covered with forest.

Due to a sharp reduction in livestock production, many pastures and hayfields were no longer in demand and began to become overgrown with tall grass. The number of cattle in the Kurgan oblast from 1990 to 2015 decreased by 8 times, sheep and goats, by 5 times. Dry, unmown grass (during the Soviet era there was practically none left) annually leads to the emergence of numerous fires, which have become a real disaster in the past three to four decades. Grass fires often spread from open areas to neighboring forests and forest belts; bushes, sedge swamps, and reed beds burn out. A large number of clutches and chicks perish in fire, and after fires there are practically no birds left in the burnt meadows and swamps, especially if they occur at the height of the breeding season. This causes a decline in the numbers of the Willow Ptarmigan, Grey Partridge *Perdix Perdix* (L.), Corncrake *Crex crex* (L.), Rails, and Crakes. In the forest stands where dry grass and litter have burned out, the species composition of birds, according to my observations, decreases by half, and their total number decreases by 5–10 times, and even the following year the number of birds in them remains significantly lower than before the fire.

Restorative successions of vegetation on pastures and fallow lands contributed to an increase in the abundance of meadow (the Common Quail *Coturnix Coturnix* (L.), Eurasian Skylark *Alauda arvensis* L., Yellow Wagtail *Motacilla flava* L.) and meadow-shrub (the Common Grasshopper Warbler *Locustella naevia* (Boddaert, 1783), Blyth's Reed-warbler *Acrocephalus dumetorum* Blyth, 1849, Booted Warbler *Hippolais caligata* (MHC Lichtenstein, 1823), Common Whitethroat *Sylvia communis* Latham, 1787, Eastern Stonechat *Saxicola torquata* (Linnaeus, 1766)) birds, which was also noted in the Trans-Urals forest-steppe [51]. On the other hand, the increase in height and projective cover of grass vegetation in meadows after the cessation of grazing had a negative impact on the numbers of waders such as the Northern Lapwing *Vanellus vanellus* (L.), Common Redshank *Tringa totanus* (L.), Marsh Sandpiper *T. stagnatilis* (Bechstein, 1803), Black-tailed Godwit *Limosa limosa* (L.), as well as the Rook *Corvus frugilegus* L. and Common Starling *Sturnus vulgaris*. These species previously used pastures as a feeding station, since they were well fertilized with always fresh cow manure and were abundant with various invertebrates, and waders also nested here. In addition to the overgrowth of pastures with tall grass, the Rook population was negatively affected by the decline in grain farming and the general reduction in the area of agrocenoses [52]. Comparison of data from surveys conducted in the mid-1980s [based on: 1, 9] and the beginning of the 2000s in the same key areas, shows a reduction in the Rook population by 5–10 times. In subsequent years, the decline in its numbers continued, many nesting colonies disappeared, and those that still survived noticeably decreased in size.

The number of waterfowl, the reserves of which were previously famous in the lake forest-steppe of Western Siberia, continues to steadily decline. A.N. Formozov [42] indicated that in 1931, 2.5 million waterfowl were harvested here, half of the harvested volumes throughout the Soviet Union. By the late 1970s, the Greylag Goose *Anser anser* (L.) commercial harvesting increased 20 times. On some lakes in the mid-20th century, goose hunting was allowed to special teams even in summer, since thousands of flocks of birds damaged crops. Between 1960 and 1975, the number of the Greylag Goose in water bodies in the south of the Tyumen oblast fell more than tenfold [Azarov 1977 – cited from: 1]. In 1982–1984, the average weighted abundance of waterfowl in the Trans-Urals forest-steppe was 25 individuals/km^2 in the Tobol valley and 103 in the Tobol-Ishim interfluve [1], which allows us to estimate the total number for the territory of the Kurgan oblast at approximately 5 million individuals. By my estimates, by the early 2000s, despite increased water levels and wetland areas, the numbers of most duck species had declined by almost another 20%. In subsequent years, the rate of decline intensified, and by the mid-2010s it had

fallen by more than half. As a result, over 30 years the abundance of ducks decreased on average by about a third [53]. Moreover, if the number of river ducks of the genus *Anas* during periods of lake filling more or less stabilized, then the abundance of diving ducks genus *Aythya* (the Common Pochard and Tufted Duck *A. fuligula* (L.)) have been declining steadily at a more even rate on average since the 1980s, and this decline continues to this day. The decline in the Gray Goose population accelerated after 1991, when spring drake hunting became an annual event in the Kurgan region. It became a powerful concern factor for geese at the height of their breeding season, forcing them to leave their nesting ponds in search of quieter places. By now, the Greylag Goose has become so rare that it is already being considered as a candidate for inclusion in the Red Data Book of the Kurgan oblast. And the total stocks of ducks, geese, and the Common Coot *Fulica atra* L. in the Kurgan oblast are estimated at barely 0.5–1 million individuals [50].

The decline in the number of waterfowl was largely influenced by limiting factors affecting birds on migration routes and in wintering areas [53]. But such factors also occur in breeding grounds. Among them, we can highlight hunting pressure, depletion of the food supply of reservoirs due to active fish farming, reduction of cultivated areas, spring burning, and predation by the Hooded Crow *Corvus cornix* L. and some species of mammals. Below I will briefly discuss them.

It is impossible to quantify all aspects of hunting pressure, but its increasing negative impact in recent decades is obvious. The number of local hunters in the region has not increased, nor have the volumes of game they take, but the intensive construction of paved roads and the increase in the number of passenger cars in the 1980s and 1990s have significantly increased the accessibility of the region's wetlands to visiting hunters. Modern hunters are much better equipped and armed, which allows them to hunt more effectively. At the same time, a decline in the level of hunting culture and ethics is noted everywhere. It must be admitted that most hunters (and even gamekeepers) do not know the protected species. There is shooting of females and shooting in flight at flocks of ducks, including from motor boats. Due to the decentralization of hunting management and a number of other reasons, the effectiveness of hunting grounds protection has significantly decreased since the Soviet times. Currently, there is no practice of keeping records of harvested individuals per species. In the issued permits it is sufficient to indicate only "duck" or "goose," which does not encourage hunters to be able to distinguish between protected species. The abolition of the mandatory hunting minimum exam also contributed to the decline in the level of hunting culture.

After the reform of the hunting industry, the centralized fight against the Hooded Crow and some other predators, which was widely practiced in the Soviet years, became impossible. There is no regulation of the numbers of the Raccoon Dog *Nyctereutes procyonoides* (Gray, 1834) and the American Mink Neovison vison (Schreber, 1777) [53]. As a result, their abundance as well as the damage they cause to populations of commercial (and other) birds have increased. The census of the Hooded Crow population in the same key areas shows an increase in its abundance several times (for example, in the Makushino district of the Kurgan oblast from 2001–2002 to 2015 by 8 times: from 0.25 to 2.1 individuals/km^2). It should be mentioned here that the number of the Black Kite has also increased several times, including after work began in the Kurgan and neighboring oblasts to build an extensive network of paved roads, which subsequently became one of the main feeding grounds of this species.

The first cases of artificial fish breeding in the lakes of the Trans-Urals forest-steppe date back to the middle of the last century, and starting around the 1980s, it has been widely used. The most intensively cultivated species were the Carp *Cyprinus carpio* L., Peled *Coregonus peled* (Gmelin, 1788) and other whitefish. Fish farming in natural water bodies inevitably reduces the food supply for ducks, whose diet includes aquatic invertebrates; in this case, according to my observations, the most food-rich water bodies, which are also of great importance for waterfowl, are primarily subject to stocking. At the same time as the abundance of the latter decreases, the number of fish-eating birds, primarily the Great Cormorant, increases. Fish farm workers are forced to fight them, scaring them away from their water bodies, but due to such disturbance, the numbers of other species are also decreasing.

Of course, anthropogenic factors affect different species of birds in different ways. For certain species, especially rare ones, it can be quite strong. In each specific case, such influence is described in the Red Data Book essays in the sections "Limiting Factors" and "Conservation Measures." For example, the rare White-headed Duck *Oxyura leucocephala* (Scopoli, 1769)—the widespread use of cheap nylon fishing nets had an extremely negative impact on its population. Until the last quarter of the last century, rural residents did not use nets; they made fishing tackle from rods or wire. And when nets appeared, the White-headed Duck (apparently due to the peculiarities of its biology) began to suffer from them more than other diving ducks. At the end of the last century, this bird was caught in dozens, if not hundreds, and then less and less often. And now it is even more common to hear about another White-headed Duck dying in the nets than to see it in the wild.

I have considered only some aspects of anthropogenic influence both on individual bird species and on the regional avifauna as a whole. At the present stage, this influence is generally less pronounced than natu-

ral influence, which is also observed in the steppe zone of the Southern Urals [48, 49]. Anthropogenic factors, unlike natural ones, despite their importance and scale, have not led to the disappearance or emergence of new species in the region over the past 40 years. However, the examples given above show that they can cause sharp changes in the numbers of individual species, and if due attention is not paid to this, some birds may even disappear as a result of their impact.

CONCLUSIONS

A striking feature of the dynamics of the bird fauna of the Trans-Urals forest-steppe over the past two to three decades is the appearance of a significant number of new southern species in its composition. These are birds of tropical genesis, settling mainly from Kazakhstan, as well as representatives of the nomadic and European types of fauna. Thus, at a distance of 500–600 km north of the previously known range boundaries, seven new species of the tropical group (the Great White Pelican, Great Egret, Black-winged Stilt, Kentish Plover, Gull-billed Tern, Caspian Tern, Eurasian Collared-dove) and three species of the nomadic type of fauna (the Little Owl, European Bee-eater, Cetti's Warbler) are nesting.

At the same time, there is a reduction in the nesting abundance of a number of species that have southern distribution boundaries in the region, which may indicate a shift of these boundaries from the forest-steppe zone to the forest zone. This northward movement of the ranges of both southern and northern bird species appears entirely natural against the backdrop of intense climate warming that began in the mid-1970s. Over the last 50 years, the average annual temperature has increased by more than 2.5°C. At the same time, only wetland species (limnophiles) exhibit a northern vector of distribution change. Climate warming has not yet led to the emergence of new types of open steppe habitats (campophylls) in the region, since zonal landscapes remain within their previous boundaries. Only two such species, the Demoiselle Crane and Little Bustard, are now actively spreading in the northern direction, but, in fact, they are only restoring their former ranges, lost after the large-scale "development" of virgin lands in the mid-20th century.

The process of settlement of limnophiles in the northern direction cannot be called uniform. The appearance of most of them in the Trans-Urals forest-steppe was noted in the early 2000s, when the reservoirs were at the stage of maximum filling. In the 2010s–2020s, the water level dropped significantly, and the process of limnophile dispersal clearly slowed down, as evidenced by the absence of new such species in the region (with the exception of the Great White Pelican) and noticeable further advancement of previously settled species. At the same time, there is no reverse movement towards the south of the boundaries of their ranges. All of them continue to be encountered just as regularly in the region, and the nesting abundance of some of them has even increased, which could have been facilitated by the displacement of some individuals from the shallow reservoirs of the steppe zone. Apparently, new waves of the introduction of southern limnophiles into the forest-steppe zone should be expected in the following periods of increased water levels. Steady climate warming, an extension of the frost-free period of the year and a relatively stable hydrological regime in the forest-steppe zone create favorable conditions for the existence of new southern species that have already appeared here. This allows us to assume that the changes in the distribution of most limnophiles occurring in the Trans-Urals forest-steppe will be irreversible in the foreseeable future. The reverse movement of their ranges to the south will obviously begin with the onset of the next cool-humid era of the centuries-old climatic cycle.

The anthropogenic impact on the regional avifauna is mainly due to the consequences of the economic crisis of the 1990–2000s in agriculture. Due to a sharp reduction in livestock production, many pastures and hayfields were no longer in demand and began to become overgrown with tall grass. This has a negative impact on the numbers of a number of waders (the Northern Lapwing, Common Redshank, Marsh Sandpiper, Black-tailed Godwit), and also causes widespread grass fires, resulting in a decrease in the abundance of meadow birds (the Willow Ptarmigan, Grey Partridge, Corncrake, Rails, Crakes). The general reduction in the area of agrocenoses caused a sharp (more than an order of magnitude) drop in the number of the Rook. For several decades, the stocks of waterfowl (river and diving ducks, the Greylag Goose, Common Coot) have been steadily declining, which, in addition to wintering and migration conditions, is negatively affected by such factors as high hunting pressure, the lack of necessary biotechnical measures (primarily regulation of the number of the Hooded Crow and predatory mammals), and the depletion of the food supply in water bodies due to active fish farming. In general, over the past 40 years, anthropogenic factors, despite their importance and scale, have had a significantly smaller impact on the regional avifauna than natural factors, and, unlike them, have not led to the disappearance or emergence of new species in the region.

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ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This work does not contain any human or animal studies.

CONFLICT OF INTEREST

The author of this work declares that he has no conflicts of interest.

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