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Ecological Value of the Sorokaoziorki Wetland Complex in the Steppe of Central Eurasia (Khakassia, Russian Federation)

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Abstract
The wetlands of Central Asia, including many of high ecological value, are poorly studied and poorly represented in international conservation activities. The Sorokaoziorki ("Forty Lakelets") complex of wetlands, located in the arid Koibalskaya steppe (Republic of Khakassia, Russian Federation), falls into this category. We documented the origin of the complex's wetlands, patterns of land use and economic activities, and use of the area by multiple bird, mammal, and fish species. The "lakelets" of the Sorokaoziorki originated from a dried river bed that refilled relatively recently with water introduced from irrigation activities. The resultant wetlands and surrounding wet grasslands within the Sorokaoziorki complex represent a refuge for wildlife, while the surrounding steppe has been turned to pasture. Located at a crossroads of bird flyways, at least 140 bird species use the Sorokaoziorki complex to nest or as a stop-over point during migration. Additionally, we documented the occurrence of seven fish, one lamprey, and seven mammal (including three bat) species within the complex. The planting of sea-buckthorn (*Hippophaë rhamnoides*) and the restriction of grazing around the edges of the wetlands in the Sorokaoziorki wetland complex has contributed to the conservation of this ecologically important area.

Keywords Wetland · Steppe · Birds · Fishes · Pasture · Grazing · Conservation · IUCN red list

Introduction

Many wetlands function as valuable habitats that support concentrations of birds and other animals. However, wetlands are often exposed to various forms of anthropogenic disturbance that degrade their value as wildlife habitat (Brinson 2011; Davidson 2014). Since some wetlands are significant to animals with territories that extend across international borders or serve as habitat for threatened species, they are of international importance (Gell et al. 2016). However, knowledge of wetland locations and extent remains poorly developed for many regions of the world (Kingsford et al. 2016). The identification and study of wetlands is especially urgent for arid areas, where these habitat types are especially rare and often threatened. A major threat to these arid-region wetlands is salinization (Herbert et al. 2015). Moreover, desertification continuously progresses in inland areas (Millennium Ecosystem Assessment 2005), with negative consequences to wetlands.

Most of the southern part of Russia is "steppe," i.e., arid to semiarid, grass-cover plains. The Russian steppe occupies about 1.2 million km^2 (www.novrosen.ru). Much of the steppe habitat has been transformed into arable land, threatening the biodiversity of the region. Given the human alterations of steppe in Russia, identification and study of the region's wetlands is especially urgent. Ramsar lists 35 wetlands located in the Russian Federation as having high ecological value (http://www.ramsar.org). Only one of these wetlands is located in steppe; an additional four are located in areas of transition from steppe to northern wet forests. The listing of only a single high-value wetland for the 1.2 million km^2 Russian steppe is hardly sufficient. The wetlands of the neighboring areas of China and Mongolia are also poorly studied and recognized internationally (Williamson et al. 2013). For these reasons, the central part of Eurasia demands special attention in the identification and study of ecologically important wetlands.

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In addition to the Ramsar list of wetlands of international importance, the 2000 Ramsar "shadow list" for the Russian Federation documents additional wetlands that seem likely to be important internationally, but lack sufficient information to determine their ecological value (Krivenko 2000). It was expected that the shadow list would stimulate explorations into the ecological values of these additional wetlands, but this has rarely happened. There remains a great gap in knowledge of the ecological value of the "shadow-listed" wetlands; the Sorokaoziorki wetland complex in central Eurasia falls into this category. The Sorokaoziorki complex is suspected to be an important habitat for several protected species and a convergence area of numerous birds (Savchenko and Savchenko 2014; Geld and Zlotnikova 2015), the reasoning for its inclusion on the Ramsar shadow list (Geld and Zlotnikova 2015). Recently, local activists have claimed that the Sorokaoziorki wetlands have become critically endangered, and that the ecosystem will be entirely destroyed in the near future. However, official inspections revealed no violation of local nature conservation regulations. Given the lack of knowledge related to this wetland complex, we conducted a study of these wetlands from 2015 to 2016 and used Ramsar listing criteria (http://www.ramsar.org) to explore the ecological value of the wetlands. We focused our surveys primarily on bird species of the area, as they represented the primary reason for considering the wetland complex as a Ramsar wetland of international importance. However, we also collected information on other animals, as well as the patterns of land use and economic activities.

Study Area

The word "Sorokaoziorki" means "Forty Lakelets." The number "forty" is often used by the area's local inhabitants as a substitute for "many." There are eight relatively large lakes (about 50 ha each) in the Sorokaoziorki complex. Surrounding the larger lakes are many, i.e., "forty", smaller lakelets. The lakes and lakelets of the Sorokaoziorki wetland complex are located in the center of an open plain known as the Koibalskaya steppe in the Republic of Khakassia, Russian Federation (Figs. 1 and 2). The Koibalskaya steppe is an area of lowland with many small hills and depressions 300 to 350 m above sea level. It is located between N 53°04′ and N 53°40′, and between E 90°17′ and E 91°52′ in a triangular area defined by the converging Abakan and Yenisei rivers to the northwest and northeast (the Abakan being a tributary of the Yenisei), and the Sayan Mountains to the south. The Sorokaoziorki wetlands are connected with the Abakan River and, therefore, the Yenisei. The Yenisei is one of the largest rivers in the world, flowing from Mongolia to the Arctic Ocean.

Initially the Forty Lakelets had been formed in a former river bed of the Yenisei; the river changed course during the Quaternary land elevation. Arid conditions in recent centuries resulted in the drying of the wetlands in the former river bed. The historically dry conditions of the Koibalskaya steppe also prevented the existence there of a large human population. However, in the 1950s, an irrigation system was built that conveyed water by canal from the Abakan River. The water amount was greater than needed for agriculture, and excess water was directed into the steppe through a number of outlets. This excess water filled the previously dry depressions in the steppe, reforming the lakelets, including the Sorokaoziorki wetlands. Afterwards, several dams and locks were built to control the water levels in the lakelets (http://sayanmuseum.eto-ya.com, Malyshev 2007). From the 1950s to the 1980s, the Koibalskaya steppe was actively developed. Large areas were converted to crop production and large cattle-breeding enterprises were started. However, following the breakdown of the USSR in the 1990s and a resultant economic decline, most agricultural activities in the Koibalskaya steppe have collapsed. Currently, cattle, horses and sheep are pastured in the steppe and most of the arable land is abandoned. These conditions more closely reflect the pattern of land use that existed there for thousands of years.

Humans have influenced the Koibalskaya steppe since prehistoric times. Artifacts from ancient cultures have been reported in the areas near the Sorokaoziorki wetland complex (Savinov 2002). Moreover, sites of pre-historic humans were found in the mountains close to the Koibalskaya steppe (Krause et al. 2010). The long presence of humans has likely resulted in a continuous decline of many wildlife species. Since the local inhabitants mainly practiced cattle-breeding, it is assumed that the steppe was damaged by over-grazing and that the water bodies eventually disappeared under such conditions. However, this process was poorly documented. It is simply known that for at least a hundred years, a small number of lakelets have existed in the Koibalskaya steppe. They were small and saline; therefore, they did not represent an interest for local inhabitants or other visitors. This suggests that the relatively recent refilling of the waterbodies of the steppe with excess irrigation water may represent a condition of the environment that is similar to conditions before the human induced dewatering of the lakelets.

Recently exploration for coal deposits in Koibalskaya steppe has started. This has provoked anxiety in many of the local inhabitants because they believe that development of coal mines in the area will destroy the lakelets and the wildlife that depend on them as habitat. It is also assumed that fire frequency has increased in the steppe due to the presence of humans, but this has also been poorly documented. Fires usually occur in spring when dry grass from the previous year remains on the steppe. Due to strong winds, spring fires often spread rapidly over large areas.

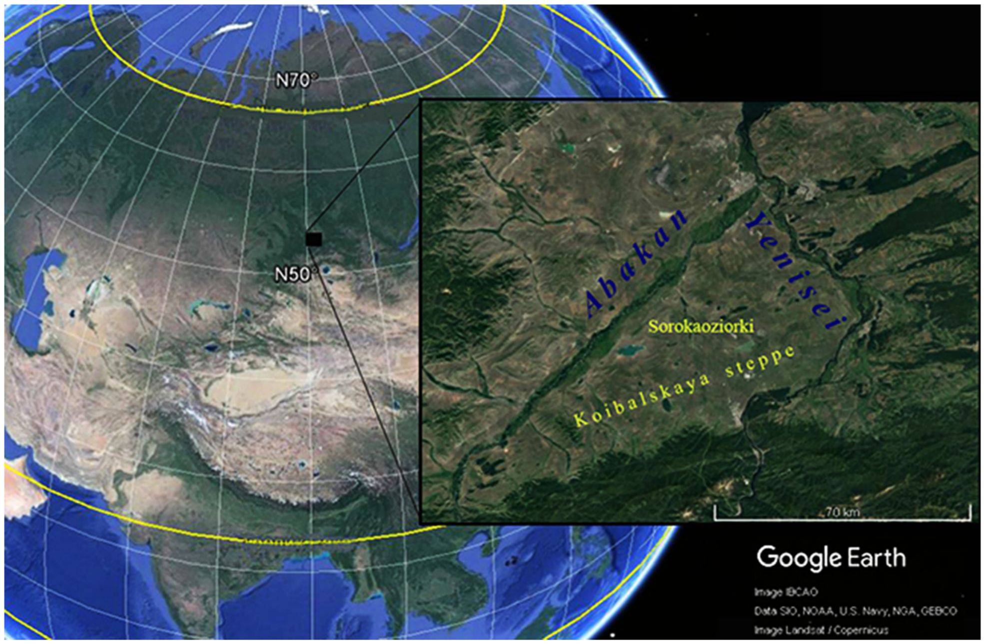

Fig. 1 Location of the Sorokaoziorki wetland complex in the Kaibalskaya steppe of the Republic of Khakassia, Russian Federation

As with most other ecological information, information on biodiversity of the Sorokaoziorki is lacking. Local sources contain information only in reference to birds (Prokofiev and Kustov 1988: Yemelianov 2000; Geld 2010; Baranov 2004; Prokofiev and Kustov 1988, 1997; Savchenko and Yemelianov 1991; Savchenko et al. 1997; Savchenko 2014; Geld and Zlotnikova 2015). However, for this group alone over 100 species have been documented, but it is unclear if all of these species still occur within the Sorokaoziorki complex. In terms of waterbird abundance, it is thought that 2000–3000 duck pairs, 80–100 heron pairs, 10–15 bittern pairs, 2–4 goose pairs, and 1–2 swan pairs nest in the Sorokaoziorki annually. In addition, large concentrations of starlings (up to 50,000 individuals), swallows (up to 150,000 individuals) and cranes (up to 500 individuals) have been documented during past migration seasons (Geld 2010).

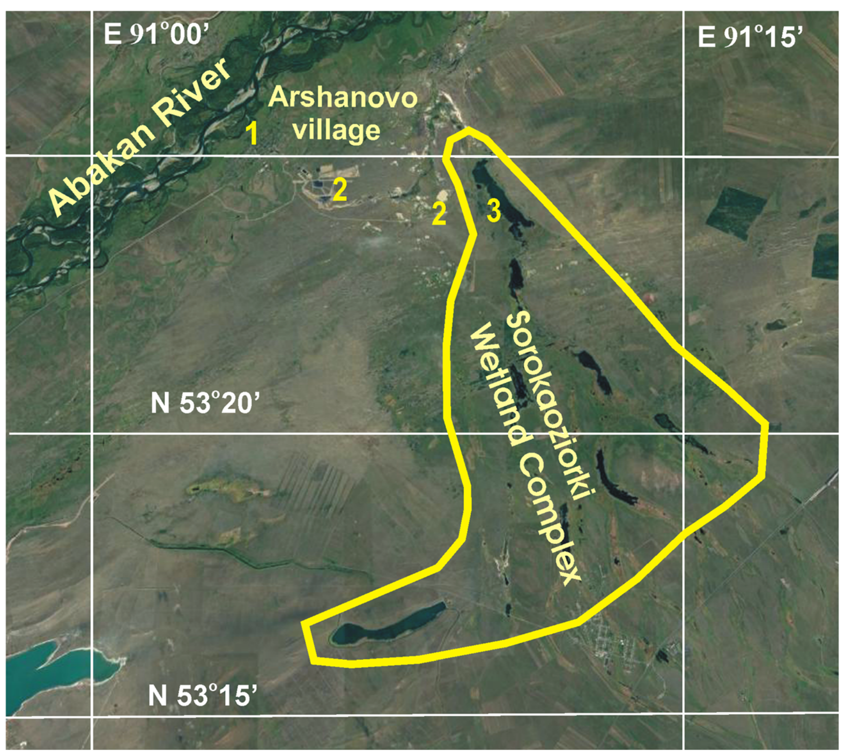

Fig. 2 Extent of the Sorokaoziorki wetland complex (outlined in yellow) in the Kaibalskaya steppe of the Republic of Khakassia, Russian Federation showing 1) location where nocturnal observations of bird migrations were conducted, 2) open-pit coal mines, and 3) mist-netting site

Methods

Borders of Lakelets and Condition of Surrounding Territory

At the beginning of our study we walked the perimeter of lakelets and surrounding wet grasslands to identify and delineate their borders (the Shadow Ramsar shadow list contains just coordinates for a single one point identifying the site). In our initial survey of the area, we recorded characteristics relevant to the ecological value of the wetland complex, e.g., areas of pasture, condition of soil, state of hydrologic alterations, location of coal mines etc. We also surveyed areas surrounding the Sorokaoziorki complex, including floodlands of the Abakan River and a neighboring lake, to find determine if wetlands of the Sorokaoziorki complex differed substantially from neighboring small water bodies and wetlands.

Bird Abundance Surveys

From April to August of 2015 and 2016, we conducted visual-observation bird surveys along multiple routes throughout the wetland areas of the Sorokaoziorki wetland complex (Online Resource Table 1). Our survey methods were similar to those of Järvinen and Väisänen (1977, 1983) and were used to estimate bird species occurrence and abundance. Sampling routes were selected to include the complete variety of local habitat types (i.e., open water, reed beds, bush, surrounding steppe vegetation). Typically, surveys were conducted in the morning between 6:00 a.m. and 11:00 a.m. local time, i.e., the period when bird activity was greatest. Observers traveled 10–20 km per day while performing surveys. Motorbikes or horses were used to reach distant parts of the wetland complex. Survey routes passed mainly along the edges of the largest lakes; however, several smaller waterbodies in the surrounding territory were also surveyed in order to include these additional wetland habitats. In open landscapes (e.g., open-water, steppe) a 100-m-wide main belt to the right and to the left of the observer was sampled. For reed-beds and bush the width of the survey was 50-m wide. During the excursions, all observed birds were identified, recorded and photographed. Observers used binoculars and a Nikon P900 Coolpix digital camera with 83× optical magnification. Bird species were identified using field guides by Brazil (2009) and Riabitsev (2014). About 90% of the observed birds were identified to species. The distance from the observer to each observed bird was estimated, and the location was plotted on the route plan by habitat type. For passerine species, a pair was inferred from a male heard singing or a group of fledglings. Density of birds was calculated only for the most numerous species; for rare species, only presence was recorded. Routes were tracked using GPS and data were processed using Basecamp and Google Earth Pro programs. In total, 111 transects were sampled with a total length of non-repeating routes of 145 km.

Nocturnal Observation of Bird Migrations

We used the "moon-watch" method to study nocturnal bird-migrations. This method is based on using a telescope to observe the silhouettes of migrating birds as they cross the bright part of the moon disc. Moon-watching allows quantitative estimation of nocturnal migration (Bruderer 2001; Baushev and Sinelschikova 2007). Each observed bird reveals some basic information: taxa, direction and altitude of flight; and an index of intensity of migration known as the Migration Traffic Rate (MTR) can be calculated. The MTR is equal to the number of birds crossing a 1-km line (front) in one hour (birds·km^{-1}·h^{-1}) or one night (birds·km^{-1}·night^{-1}; Bolshakov et al. 2002, Baushev and Sinelschikova 2007). Based on the outlines of bird silhouettes and patterns of flight we were able to identify 70–80% of birds to order or family, but very seldom to species. Observation was possible no more than 14 nights per moon cycle, when the visible part of its disc was at least 50%. Observations were not conducted on overcast nights. For our moon-watch surveys, we used a 40× telescope and observed for 30-min intervals when the moon disc was as high as 20° above the horizon. Movements and size of the moon are considered in subsequent calculation of the MTR (Bruderer 2001; Baushev and Sinelschikova 2007). Recorded birds were divided into large taxonomic groups. Moon-watches were carried out from the village of Arshanovo (N 53°24′48.85″, E 91°03′35.41″; Fig. 2). Nocturnally migrating birds pass in a "broad front" of rather uniform density and species composition throughout tens kilometres (Dolnik and Bolshakov 1985; Liechti et al. 1996; Bruderer 2001). Thus, observation from the village 6 km west of the lakes was assumed to be characteristic of night migration above the whole Koibalskaya steppe, which is about 60-km wide. The total number of nights during which surveys were conducted was 41 in 2015, and 26 in 2016 (Online Resource Table 1).

Mist-Netting of Birds

In addition to our daylight and moon-light bird surveys, we also captured birds using mist-nets deployed in the center of wetlands closest to the largest lake (Lake Turpanie; N 53°23′ 53.23″, E 91°10′24.64″). Five transects of 3-m-high mist-nets were installed; the total length of each transect varied from 106 to 188 m. The nets were laid out through three different habitat types, bush congestions, grasslands and reed beds. This netting design facilitated capturing birds of different species in their preferred habitats. The birds were netted following guidelines of the European-African Songbirds Migration Network Field Instructions (Bairlein et al. 1995). Bird netting was carried out during the seasons of migration, i.e., April–May and September of 2015, and in April–May of 2016. The total number of days sampled was 56 (Online Resource Table 1). The nets were open 24 h each day, but birds were captured only from 6:00 a.m. local time to dusk. All captured birds were identified to species and banded. The sex and age were recorded when possible to determine. Captured birds were weighted to the nearest 0.1 g. Based on recaptures (multiple captures), duration of stopover and its efficiency, i.e. mass gain or loss at stopover site between first and last capture (Dunn 2001) in autumn, was estimated for the most abundant species. We compared body mass of birds between first and last capture using a Wilcoxon Matched Pairs test. Capture-mark-recapture (CMR) statistics for the study of migratory stopovers were used. CMR analysis of stopover length was performed following methods to Lavée et al. (1991) and Kaiser (1993). The fat mass in each bird was estimated based on the methods of Ellegren and Fransson (1992).

Additional Observations

During the surveys for bird species, we recorded the occurrence of mammals, their shelters and footprints. Moreover, we conducted observations of bats. Small lakelets about 50 m in diameter and surrounded by dense arboreal vegetation were considered as the best habitat for bats (up to six bat species have been observed in such places simultaneously in a similar climatic zone [Kuziakin 1950]). Five such lakelets were selected and surveyed for the occurrence of bat species. Bat surveys were conducted during the first two hours after sunset. A Pettersson Model D200 Ultrasound Detector was used to reveal the presence of bats and to aid with their identification to species. Recordings of hunting bats were compared with recordings collected by Barataud (2015) for species identification.

Since the local inhabitants often claim that the lakelets are polluted with coal mining waste product and the fishes perish there, we also sampled fishes. Small fishes were captured by 5-mm-mesh landing-nets and a 10-mm-mesh creel (1 m long, 50 cm in diameter). We sampled along the coasts of the largest lake (Turpanie) and several, neighboring, small waterbodies (Online Resource Table 1). Following species identification, all captured fishes were released into the lake or wetland from which they were captured.

Results

Borders of Lakelets and Condition of Surrounding Territory.

The Sorokaoziorki wetland complex differs significantly from the surrounding territory. Neighboring lakes and lakelets, as well as the flood-land of the Abakan River lacked large areas of shallow waters with macrophytes. We estimated the total area of the Sorokaoziorki wetland complex to be 100 km^2 (Fig. 2); consisting of 22.5 km^2 of open water (in summer), 47 km^2 of wet grasslands and shrub at the coasts, and 30.5 km^2 of steppe between the lakelets.

The coasts of the wetlands were surrounded by shrub consisting mainly of sea-buckthorn (*Hippophaë rhamnoides*) (Fig. 3). Woodland belts of Siberian elm (*Ulmus pumila*), birch (*Betula pendula*), and pine (*Pinus sylvestris*) occurred near the lakelets, but the total area covered by these trees was insignificant compared to that covered by sea-buckthorn. According to information obtained from local inhabitants, most planting trees in the area occurred before 1980. Now these treed areas occupy plots of up to 1 ha and serve as refugia for birds, mammals and other animals, while the surrounding lands have been converted to pasture. Indications of cow, horse and sheep use of the area were found during every survey. Plots with exterminated vegetation from desertification were noted. The Water Code of Russia does not allow grazing along the edges of water bodies, but this is not enforced at all water bodies. The main stream of the Abakan River and the biggest lakelets are regulated in this respect. The smallest lakelets and brooks remain largely unnoticed by authorities, therefore livestock use them without restriction. Meanwhile these small water bodies are of special ecological value for birds and other animals. They illustrate well, how the loss of wetlands takes place in a steppe: extermination of arboreal vegetation at the banks, washout of soil, shallowing, and consequent transformation of wetland into dry land (Fig. 4). Many of the lakelets have disappeared, and this process continues to progress. Recently deceased bivalves were found in some dry depressions (Fig. 5).

We identified two open-pit coal mines that were surrounded by mounds of excavated ground to the west of the Forty Lakelets area. One of these mines bordered the wetland complex (Fig. 2). Both of these mines require the pumping and use of groundwater in the mining operation. While water flows from the mines are directed into Abakan river by canals and they do not directly pollute the surface waters of the Sorokaoziorki wetland complex, disturbance of groundwater levels by pumping could impact water levels of the lakes and wetlands in the complex. Meanwhile, the local irrigation system that initially regulated water level in the lakelets appeared to be abandoned. During the summer 2016, the small dams between lakelets were partly destroyed and the main canal from the Abakan river was dry.

Bird Use and Abundance

In total, we observed 124 bird species from 14 orders during our 2015 and 2016 surveys of the Sorokaoziorki wetland complex (Online Resource Table 2). The most abundant species

Fig. 3 A typical landscape of the Sorokaoziorki wetland complex in the Kaibalskaya steppe of the Republic of Khakassia, Russian Federation

were the Mallard (*Anas platyrhynchos*; 730 birds observed), Northern Pintail (*Anas acuta*; 570 birds observed), Ruddy Shelduck (*Tadorna ferruginea*; 310 birds observed), Western Yellow Wagtail (*Motacilla flava*; 1200 birds observed), Booted Warbler (*Hippolais caligata*; 320 birds observed), Common Stonechat (*Saxicola torquata*; 650 birds observed), Eurasian Skylark (*Alauda arvensis*; 5500 birds observed), Isabelline Wheatear (*Oenanthe isabellina*; 870 birds observed), and Black Kite (*Milvus migrans*; 1300 birds observed). The density of individuals of these abundant species exceeded one individual per route km. Density of these abundant species in the three dominant habitat types are presented in Online Resource Table 3. The density of other birds did not exceed one individual per 10 km of route. The low frequency of occurrence for these species precluded us from making quantitative assessments of these species. Some of the less abundant species were Pintail (*Anas Penelope*), Northern Shoveler (*A. clypeata*), Common Teal (*A. crecca*), Pallas's Gull (*Larus ichthyaetus*), Black-headed Gull (*L. ridibundus*), Common Sandpiper (*Actitis hypoleucos*), Green Sandpiper (*Tringa ochropus*), Pied Avocet (*Recurvirostra avosetta*), and Little Ringed Plover (*Charadrius dubius*). These species were recorded in the lakes and lakelets of the Sorokaoziorki wetland complex but occurred more rarely or were distributed

Fig. 4 Drying of a small "lakelet" in the Kaibalskaya steppe of the Republic of Khakassia, Russian Federation

Fig. 5 *Anodonta* shell (foreground) in a dry "lakelet" of the Sorokaoziorki wetland complex in the Kaibalskaya steppe of the Republic of Khakassia, Russian Federation

sporadically, and big concentrations consisting of more than ten birds did not occur. The small, partially dried water bodies (100–200 m^2 in size) and the surrounding wet grasslands were very attractive for waterfowl and waders including some "vulnerable" and "near-threatened" species, e.g., Common Pochard (*Aythya ferina*), Swan Goose (*Anser cygnoides*), Northern Lapwing (*Vanellus vanellus*), Eurasian Curlew (*Numenius arquata*).

Nocturnal Bird Migrations

During our nocturnal moon-watch surveys, we documented bird migrations over the Koibalskaya steppe. In 2015, we sighted 151 birds in our spring moon-watches, and 400 in our autumn watches; in 2016, we sighted 85 birds in our spring watches, and 111 birds in our summer watches. Birds recorded during nocturnal migration belonged to eight orders; about 80% of birds sighted were identified to the order level. In April and May, passerines composed up to 70% of the total migratory flux. In mid-summer passerines were reduced to about 40% of the flux, but increased back to 75–80% in August and September. The orders *Anseriformes* and *Charadriiformes* composed 9–20% of all birds sighted. The spring Migration Traffic Rates (MTR) were calculated to be 440 birds·km^{-1}·h^{-1} and 890 birds·km^{-1}·h^{-1} in April and May, respectively. The median altitude of sighted birds during spring migration was 175 m AGL. About 90% of birds flew at altitudes below 500 m AGL. Flight direction data revealed that 61% of birds passed in a typical seasonal northward direction. Summer migration was not intensive, an average of 280 birds·km^{-1}·h^{-1} were sighted during moon-watches in July. The MTR was 1020 birds·km^{-1}·h^{-1} and 1710 birds·km^{-1}·h^{-1} in August and September, respectively. In October the MTR was only 270 birds·km^{-1}·h^{-1}. The median height of night migration was 310 m AGL in autumn. About 90% of birds flew below 800 m AGL. Such height distribution was typical for plain areas of Europe and North America (Bruderer 2001). About half of birds (45%) in autumn were flying in the appropriate SW migratory direction. By assuming the duration of night to vary from 10 h in the middle of April to 12 h at the end of September, during one average April night about 4000 birds crossed a 1-kilmeter front (birds·km^{-1}·$night^{-1}$), in May – 6000, in July – 1500, in August – 10,000, in September – 17,000 birds·km^{-1}·$night^{-1}$ above the Koibalskaya steppe.

Mist Netting

We captured 1606 birds of 60 species (7 orders) during our mist-netting efforts (Online Resource Table 2). The bulk of these birds were passerines that winter in Africa, Middle, South and South-Eastern Asia. Four most abundant species, Common Chiffchaff (*Phylloscopus collybita*), Black-faced Bunting (*Emberiza spodocephala*), Siberian Rubythroat (*Luscinia calliope*), and Bluethroat (*Luscinia svecica*), increased in body mass between the first and last capture dates, but the difference was significant in only two species, Common Chiffchaff and Black-faced Bunting (Online Resource Table 4). Bird captures were included in the lists of bird species of Forty Lakelets (Online Resource Table 2). This list includes 170 species: 83 species were only observed during excursions, 41 species were both observed and caught, 19 species were revealed only by capturing, and 27 species were added from the literature. According the IUCN Red List (http://www.iucnredlist), five of 170 species are "vulnerable", two "endangered", seven "near-threatened", and five "have not yet been assessed". The others are classified as "least concern", but 40 of these still require attention because their populations are declining.

Additional Observations

Wild mammals turned out to be rare in the habitats around the Forty Lakelets. Murine rodents and long-tailed ground squirrel (*Spermophilus undulates*) holes occurred rarely at the wetlands. Beavers (*Castor fiber*) were found in streams between lakelets. Tracks and shelters of fox (*Vulpes vulpes*), and steppe polecat (*Mustela eversmanii*) were noted as well in small numbers.

We detected bats at three lakelets. Several tens of pond bats (*Myotis dasycneme*) have been observed there. Moreover, one Daubenton's Bat (*Myotis daubentoni*) was observed at the brook linking the lakelets, and one Northern Bat (*Eptesicus nilssonii*) was captured during our mist-netting of birds. The Pond Bat is of special interest as it is catagorized as a "near-threatened" species in the IUCN red list. The other two bat species are usually considered "common" or of "least concern."

We captured seven fish species during or surveys, Gudgeon (*Gobio gobio*), Common Minnow (*Phoxinus phoxinus*), Perch (*Perca fluviatilis*), Pike (*Esox Lucius*), Crucian Carp (*Carassius gibelio*), Common Carp (*Cyprinus carpio*), and Common Dace (*Leuciscus leuciscus*). Lampreys (*Lethenteron kessleri*) were also present in some of the streams. Bivalves (*Anodonta cygnea*) and, Narrow-clawed Crayfish (*Astacus leptodactylus*) were also noted in the lakelets during our sampling of fishes. Lampreys and crayfish are especially sensitive to eutrophication and other negative anthropogenic impacts to water bodies, so their presence is evidence of good water quality. Most of the recorded aquatic species are of the "least concern" category of the IUCN red list. However, the status of the Lampreys and Crucian Carp have "not yet been assessed." The Common Carp is considered "vulnerable" on a global scale (Freyhof and Kottelat 2008), but it seems that this concerns the wild native populations of Europe. In Russia, all three of these species are considered common.

Discussion

Data we collected during our surveys of the Sorokaoziorki provide evidence that this important wetland complex meets Ramsar criteria for designation as a wetland of high ecological value (see: http://www.ramsar.org/sites/default/files/documents/library/ramsarsites_criteria_eng.pdf). For example, the Sorokaoziorki complex supports vulnerable threatened species and ecological communities, supports populations of animal species important for maintaining the region's biological diversity, and supports bird species during critical migrations. The wetlands of the Sorokaoziorki are a refuge for wildlife surrounded by vast pastures, as such, they are critical to conservation of the region's biodiversity. The significance of this wetland complex is also demonstrated by the occurrence of the 170 bird species that inhabit the area. The Sorokaoziorki wetland complex is also located at a critical hub where the Central-Asian flyway overlaps other flyways that reach to Africa, Eurasia, and Australia (Galbraith et al. 2014).

Our observations revealed a considerable night passage of birds over the Koibalskaya steppe. The frequency of bird observations (800–1710 birds·km^{-1}·h^{-1}) can be described as medium to high when compared to rates from other regions. For example, Kazakhstan (420–490 birds·km^{-1}·h^{-1}; Dolnik and Bolshakov 1985), central Asia (270–1000 birds·km^{-1}·h^{-1}; Dolnik and Bolshakov 1985), and southern Siberia (420–883 birds·km^{-1}·h^{-1}; Savchenko and Savchenko 2014). Our observed rates are comparable with those of the Yenisey-Ob' (1083 birds·km^{-1}·h^{-1}) and Yenisey-Angara (1009 birds·km^{-1}·h^{-1}) areas of central Siberia (Savchenko and Savchenko 2014) However, in some locations of Europe, the intensity of bird migration is as much as three times higher than in Siberia. For example, at the foothills of Alps bird migration rates in autumn of 2800 to 4500 birds·km^{-1}·h^{-1} have been recorded (Liechti et al. 1996); and at the coasts of the Baltic Sea (Courish Spit) the rate of autumn migration reached up to 4000 birds·km^{-1}·h^{-1} (Bolshakov 1981).

Central Eurasia and southern Siberia contain numerous mountains that can represent obstacles for some migratory birds. However, birds can penetrate into the Koibalskaya steppe following the floodplains of the Abakan and Yenisei Rivers and the relatively low altitude corridors that the rivers provide between mountains. In arid regions, chains of lakes such as found in the Sorokaoziorki complex facilitate water-bird migrations (Savchenko and Savchenko 2014). We hypothesize that this is why we observed complicated directional patterns of nocturnal migrations in both seasons, e.g., in spring only 61% of birds pass in a northward direction typical for that season; in autumn about half of birds (45%) passed in the typical southward direction.

The main part of the Koibalskaya steppe is hardly suitable for stopovers, with the exception of a few small areas; the Sorokaoziorki wetland complex is one of these exceptions. For waterfowl and passerine birds it is suitable for migratory stopovers in its reed beds, shrub and steppe habitats. For four species of passerines, we revealed an increase in body mass during their stopover in the complex. Thus, for at least these four species the habitats of the Sorokaoziorki wetland complex are sufficient to meet foraging and rest needs. Plenty of sea buckthorn berries and reed beds for roost also attract Thrushes, Starlings and Tree Sparrows. This makes the wetlands of the Sorokaoziorki wetland complex important as a stopover site.

Other animals of the Sorokaoziorki are of local interest. However, its significance with respect to bats is likely of international interest due to the occurrence of the Pond Bat. This species was recently considered to be in the "vulnerable" status. Its status was revised because experts in Russia reported very large numbers of them (100,000–150,000), and in Europe relatively large numbers were found in some countries (Limpens et al. 2000). However, this species was not studied in other parts of its range. In Europe, it is considered one of the rarest and least-studied bat species (ibid.), but it seems to be rather common for the studied area. It is likely that these wetlands provide for the existence of a large population of

Pond Bats. In Russia, only three large populations are known: at the Volga River (Smirnov et al. 2008), in Northwest Russia (Kovalyov and Popov 2011), and in the Ural Mountains (Orlov 2000). About 1000 Pond Bats or even more were noted in hibernacula in each location. In the other parts of their distribution area in Russia, only several dozen individuals were registered either in hibernacula or in summer habitats. The pattern of distribution of this species spans just the islets from northern Kazakhstan to the western extreme of Europe (Limpens et al. 2000). Probably, such a Khakassian islet contains big number of Pond bats. If this is the case, the population in the Sorokaoziorki wetland complex would consist of about 1% of the individuals of the wetland-dependent non-avian animal species, i.e., another wetland-of-high-ecological-value criteria designated by Ramsar.

The Sorokaoziorki wetland complex is also of interest due to what it reveals in terms of anthropogenic impacts to wetlands in arid areas, as the anthropogenic influences can be dualistic. For the Sorokaoziorki wetland complex, anthropogenic influences were largely negative in the context of global history and prehistoric time. However, starting in the 1960s, the positive influence of excess irrigation water flowing into the complex created the wetlands anew. At the time of our survey, the wetlands of the Sorokaoziorki had reached a relatively stable condition. Human activities still exert several negative influences upon this area, but they have not (yet?) destroyed the Forty Lakelets. The Sorokaoziorki wetlands and the entire Koibalskaya steppe demonstrate the compromise between traditional land use and the need for nature conservation. Historic and economic circumstances resulted in the steppe being transformed into pasture and arable lands. The negative impact upon wildlife of this process is partly balanced by the tree planting, as well as the Water Code of Russia that restricts human activities (including cattle grazing) at the edges of water bodies. The planting of sea-buckthorn turned out to be especially successful. This tree turned out to be relatively resistant to continuous pressure of fires and trampling down of the soil as it is able to recover and spread due to basal shoots. Moreover, sea-buckthorn produces berries, a good food for birds, hence it can be spread by birds over large areas. Such shrub conserves at least a part of the wildlife in areas where over-grazing is unlikely to end. It is easy to imagine what would happen without these measures – further degradation of wetlands, and likely losses of wildlife and plant species from ecologically important areas, such as those currently preserved in the Sorokaoziorki wetland complex.

Thus, in the case of the Khakassian "Forty Lakelets" natural and anthropogenic processes illustrate a "simple" model for the formation of valuable wetlands in arid steppe: a river changed course; puddles, lakelets and wet grasslands remained in the former river bed; water from irrigation systems was introduced, trees were planted at the banks of the newly-formed lakelets, and the grazing adjacent to the lakelets was restricted; finally a system of small water bodies surrounded by wet grasslands formed at the center of the steppe. This object created a refuge not only for water birds and aquatic animals, but for other animals as well, while the surrounding area was totally replaced by pasture. This model illustrates a pattern of conservation activity which can be applied to other territories.

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