Populations of Little Bustards *Tetrax tetrax* in Kazakhstan have rebounded following a period of agricultural abandonment

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Summary: Numbers of the Little Bustard *Tetrax tetrax* in Kazakhstan were probably high until the first half of the 20th century, when the large-scale conversion of steppes into arable land combined with uncontrolled hunting led to widespread population declines. After the collapse of the Soviet Union, the population of the species began to increase again in the country. Currently, its key habitats are the steppes and semi-deserts of central, northern and western Kazakhstan, where it appears to do well in undisturbed steppe, hayfields and abandoned crop fields. It is found at lower densities in foothills in the south-eastern part of the country and across the semi-deserts of the south. We used density estimates from surveys conducted in central Kazakhstan in 2011 to extrapolate population estimates for the Little Bustard across similar suitable habitats in the northern regions of the country. In the southern regions, where the species gravitates to foothill steppes and meadows and is recorded at lower densities in semi-desert habitats, we based our estimate on the sum of maximum counts at key sites. Our estimate of the total population of Little Bustards breeding in Kazakhstan is 210 900 individuals (123 400–342 200, a range which reflects uncertainty concerning the sex ratio). The main threats are land-use changes impacting breeding success and female survival, collisions with the expanding powerline network, and a low but persistent level of poaching.

INTRODUCTION

The limited historical records available indicate that in the first half of the 20th century the Little Bustard *Tetrax tetrax* was breeding in foothills in the south of Kazakhstan (Gavrin 1962) and was common in steppes in the north and east of the country, where congregations of thousands were recorded (Gavrin 1962, Potapov & Flint 1987). A large-scale conversion of natural steppe to arable land and uncontrolled hunting led to a sharp decline in numbers by the 1950s (Gavrin 1962), and possibly to the species' extirpation from some regions by the 1960s–70s (Kovshar' 2019). However, towards the end of the last century, numbers of Little Bustards were noted to increase in many regions of Kazakhstan (Gubin 2007). Such increases occurred among breeding Little Bustards in the northern (Vilkov 2014, Sorochinskii 2023, Zuban *et al* 2025), eastern (Berezovikov & Anisimov 2013, Berezovikov & Feldman 2015, Starikov 2015), central (Yakovlev *et al* 2016, Bragin 2019) and southern (Gubin & Karpov 1999, Kolbintsev 2015, Shakula *et al* 2017) regions of the country. Similar increases in abundance were noted for other steppe bird species during this time (Kamp *et al* 2011) and attributed to the increased availability of suitable habitats associated with the abandonment of large areas of arable land in the 1990s. In the first decade of the 21st century, the Little Bustard was recorded as breeding in 21 Important Bird Areas (IBAs) of the country, out of 127 total IBAs described (BirdLife International 2025). At that time, the Little Bustard was assessed as Category II in the Red Data Book of Kazakhstan, as a species that was recently threatened with extinction but beginning to increase in numbers (Gubin 2010). BirdLife International (2018), categorising the species as globally Near Threatened, estimated a total of 20 000 individuals for Kazakhstan and Kyrgyzstan combined, but recognised that this was probably an underestimate.

In northern Kazakhstan, the Little Bustard is currently found breeding across vast areas of steppe, semi-desert and agricultural landscapes (Berezovikov & Anisimov 2013, Vilkov 2014, Bragin 2019). Suitable breeding habitats for the species across the drier southern provinces are limited to the foothills of mountain ranges or meadows around waterbodies and in riverine floodplains. Although it is unknown when Little Bustards began to use anthropogenically modified habitats, recent publications suggest that

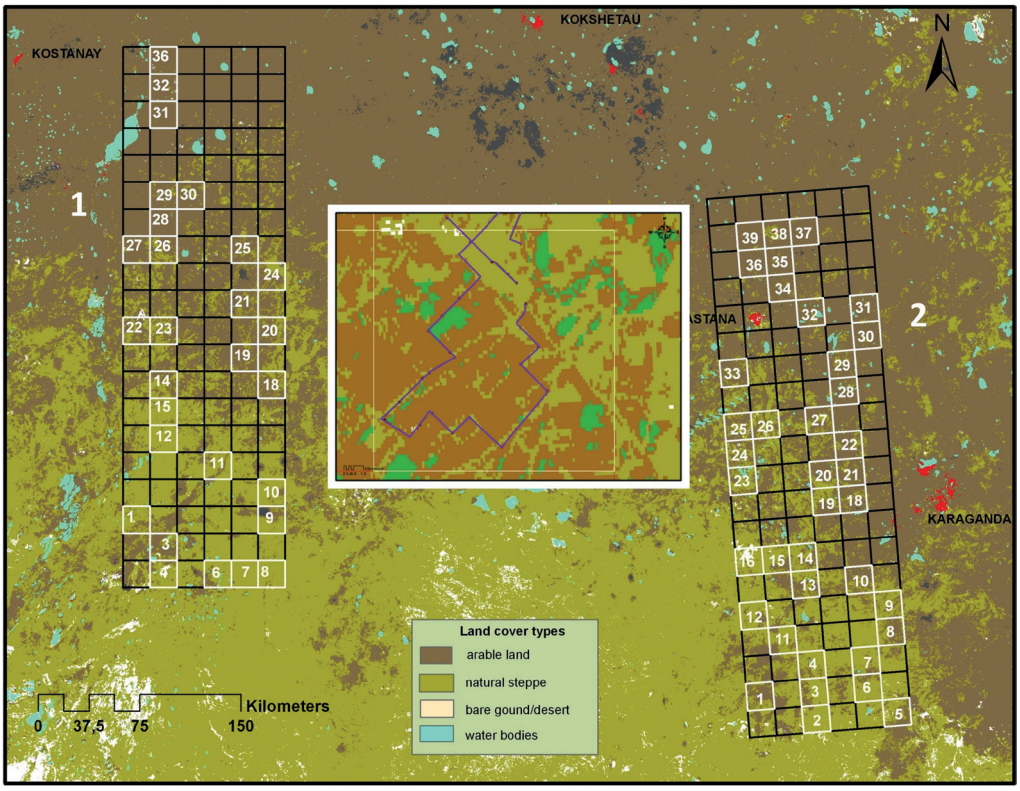

Figure 1. Map of sampling plots for surveys of steppe breeding birds in central Kazakhstan in April and May 2011. Rectangles 1 and 2 represent two major survey regions, subdivided into numbered 20×20 km survey plots. The inset (white rectangle) provides an example of a driven transect laid out in one of these numbered plots (reproduced from Koshkin 2011). Urban areas are represented in red and labelled.

breeding birds are found on grazed natural steppe and arable fields under fodder and cereal crops (both abandoned and active) (Gubin & Karpov 1999, Gubin 2015, Starikov 2015, Shakula *et al* 2017).

In the 20th century, Little Bustards were scarce on migration in Kazakhstan. Shevchenko *et al* (1993) cited the following maximum autumn counts of individuals in the north-west of the country: 170 (1957), 40 (1964), 250 (1972), 30 (1977), 300 (1985). For the same general area, Shevchenko *et al* (1977) reported a maximum day count of 79 birds (in six flocks) during spring migration in April 1965.

Incidental data this century show a trend towards increased size of migratory flocks. For example, in September 2007, between the Turgen' and the Issyk rivers in Almaty province, Karpov (2008) observed many small groups of Little Bustards, as well as two flocks of 100 and 200 individuals. In March 2016, flocks of 100–400 and aggregations of up to 1500 were regularly observed near Bozhban settlement in central Turkistan province (Gubin 2020). In September 2016 T Iskakov recorded a flock of 700 in Akmola province, and in March 2024 G Dyakin recorded a flock of 200 in Almaty province (Birds.kz 2024). An aggregation of up to 400 was recorded near Astana on 22 August 2024 (RU pers obs).

The main wintering grounds of Little Bustards breeding in central and eastern Kazakhstan are located in Uzbekistan, Turkmenistan and Iran and, for birds breeding in the west of the country, probably the Caucasus region (Gauger 2007). Although there are no published historical records of Little Bustards wintering in Kazakhstan, the

observation of 141 birds west of Shymkent city in Turkistan province on 20 January 2024 (https://kz.birding.day/) suggests that wintering takes place, but is probably rare.

In recent decades, there has been little research on the Little Bustard in Kazakhstan, except for two local studies of the biology of the species in the south of the country (Karpov & Gubin 1993, Gubin & Karpov 1994). Data on the abundance of the species has largely derived from more general surveys, *eg* a survey of breeding steppe bird species over an area of 96 000 km^2 in central Kazakhstan from April–May 2011, when a mean density of breeding male Little Bustards of 0.24 individuals per km^2 (95% CI; 0.14–0.39) was reported (Koshkin 2011). Densities of the species were five times higher in abandoned and recently mown perennial grass fields (hayfields) than in undisturbed steppe, with medium densities in abandoned arable fields and very low densities in cultivated fields (Koshkin 2011). During surveys of Asian Houbara *Chlamydotis macqueenii* in April 2010 east of lake Balkhash, 48 Little Bustards were recorded along a 173 km route, and a density of 1.39 individuals/km^2 was obtained for a 200 m-wide survey strip. Extrapolation of this density to the local area of suitable habitat (160 km^2) suggested a total population of 223 individuals (Gubin 2015).

METHODOLOGY

In consideration of the different habitats used by Little Bustards in the north and south of Kazakhstan, and the different data sources available, we developed two methodologies to estimate the species' abundance in Kazakhstan, one for the northern provinces (West Kazakhstan, Atyrau, Aktobe, Kostanay, Ulytau, North Kazakhstan, Akmola, Karaganda, Pavlodar, Abai and East Kazakhstan) and one for the southern provinces (Jetysu, Almaty, Jambyl, Turkistan, Kyzylorda and Mangystau). We then sum these two regional estimates to derive a national estimate.

Plate 1. Male Little Bustard near Astana, May 2020. © *R Urazaliyev*

Plate 2. Female Little Bustard over an arable field, central Kazakhstan, April 2011. © *M Koshkin*

Northern provinces

Our abundance estimate for Kazakhstan's northern provinces combines data from two relatively recent studies involving Little Bustards. The first assessed the abundance of several bird species nesting in steppe and semi-desert biomes in central Kazakhstan, during which the density of the Little Bustard was estimated in five major land-use types (Koshkin 2011). The second study modelled the spatial distribution of the species in the northern regions of the country, based on presence points and several environmental predictors (RU unpubl data).

For the first study, driven transects were conducted in April and May 2011 at two sites located in the central-northern part of the country (Akmola, Karaganda, Kostanay and Ulytau provinces) with a total area of 96 000 km^2 (Figure 1), using distance sampling (Buckland *et al* 2008). As the survey design employed random sampling within 64 20×20 km plots, the recorded average density of the species may be considered representative of the total area surveyed. As the data were greatly skewed towards the more conspicuous breeding males (Plate 1), the analysis was limited to observations of males only, but the surveys also recorded some females (Plate 2).

The second study used the maximum entropy method implemented in MaxEnt software (version 3.3.1: Soberon & Peterson 2005, Phillips & Duduk 2008, Phillips 2015) to model the breeding distribution in steppe and semi-desert zones. MaxEnt constructs probabilistic models of species distributions based on occurrence locations and a set of environmental and climatic predictors. Little Bustard locations were obtained from field surveys conducted by the Kazakhstan Association for the Conservation of Biodiversity (ACBK) between 2009 and 2017, involving around 2000 walked and driven transects, as well as records obtained

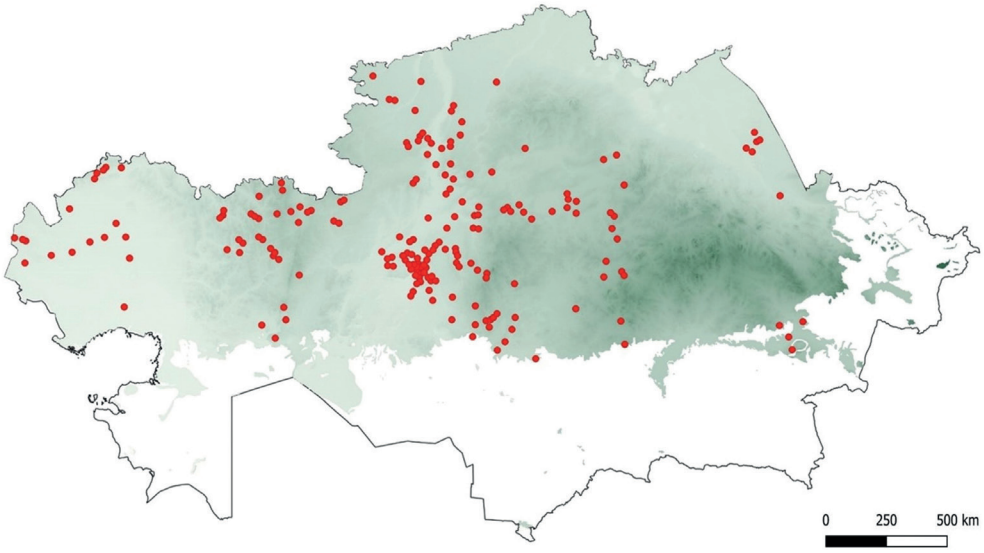

Figure 2. Spatially thinned Little Bustard observations (red dots) in Kazakhstan during the breeding season (April–June; from surveys conducted from 2009–2017 and citizen science databases queried in 2017) used to model the spatial distribution of the species in MaxEnt (198 points). Grey-green shading represents areas of steppe and semi-desert biomes (Econet 2006). Darker green colours represent higher elevations.

in 2017 from a national birdwatching database (https://kz.birding.day/), and the World Birds Database (https://avibase.bsc-eoc.org/avibase.jsp?lang=EN). A total of 644 breeding season (April–June) presence points were obtained. To avoid overweighting the model, these locations were spatially thinned using the Spatial Rarefy tool in ArcGIS version 10.6, resulting in 198 observation points used for modelling (Figure 2).

We included the following layers as environmental variables potentially affecting the distribution of the Little Bustard: 1. Land cover and land use (GLC_FCS30-2015: Zhang *et al* 2021); 2. elevation and relief (downloaded from http://www.srtm.csi.cgiar.org); 3. Normalised Difference Vegetation Index (NDVI) for April, May and June (downloaded from http://free.vgt.vito.be); 4. temperature (annual average and in the hottest month; BIOCLIM v1.4; https://www.worldclim.org); 5. precipitation (annual average and in the driest month; BIOCLIM v1.4); and 6. distance to nearest waterbody and nearest settlement (calculated in ArcGIS). Modelling was conducted at a spatial resolution of 1 km^2 across the steppe and semi-desert ecozones (as defined by Econet 2006). The MaxSSS (Maximum Sum of Similarity Scores) technique was used to identify the threshold where the model's predictions are most similar to the actual, known outcomes (*eg*, whether the species is truly present in certain areas), ensuring a balance between accuracy and reliability. To assess model performance, we used the area under the curve (AUC) of the receiver operating characteristic (ROC) plot, a threshold-independent and prevalence-insensitive metric. Following Swets (1988), models with an AUC ≥ 0.70 were considered reliable for further analysis.

As noted above, our survey method detected primarily males. To estimate the total number of breeding birds for the northern provinces of Kazakhstan a sex ratio of 1:0.4 (M:F) was used, which is estimated for Spain and Portugal, where similar agricultural conditions which result in higher female mortality are encountered (Serano-Davies *et al* 2023).

Southern provinces

To estimate abundance in the southern provinces, we conducted a review of all available sources from the last 35 years, including journal publications and databases. We were able to locate only four sources which provided local population estimates (Table 1). We summed the maximum abundance estimates for each area/location to reach a minimum estimate for the southern regions of the country. The resulting estimate of breeding individuals (both sexes) was based on abundance data of different quality, including publications that referred to 'breeding individuals', 'breeding pairs' or 'breeding males'. When the last category was used, the number of breeding individuals was inferred using a 1:0.4 sex ratio.

Table 1. Published estimates and records of breeding Little Bustards (≥ 10 individuals) in southern provinces of Kazakhstan. Where records refer to 'breeding males', the number presented here adds an equal number of females.

Year	Month/ season	Breeding individuals	Area	Province	Source
1991	spring	84	surroundings of Bilikol Lake	Jambyl	Gubin & Karpov 1994
2017	April	700	suitable habitat within Turkistan and the southern part of Jambyl provinces	Turkistan/Jambyl	Shakula *et al* 2017
2000–2002	August	14	western part of the Alakol depression	Jetysu	Berezovikov & Anisimov 2013
2006	spring	80	IBA 'Donyztau cliff faces'	Aktobe (southern portion)	BirdLife IBA Database

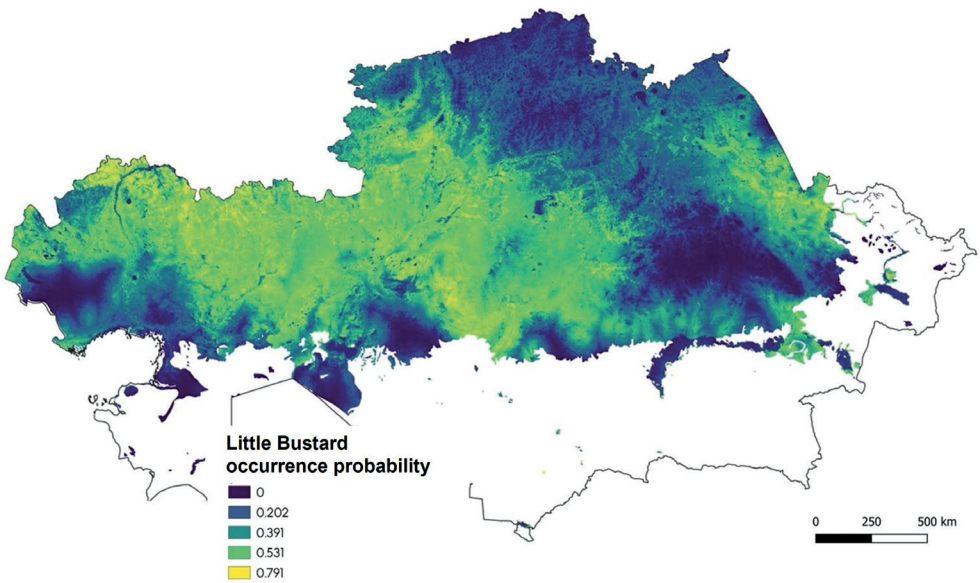

Figure 3. Environmental suitability for breeding Little Bustard in northern Kazakhstan, as predicted by MaxEnt, based on 198 location points and 11 topographical and climatic layers. Brighter colours (yellow and green) represent environments of higher suitability, with values of 0.5 or greater predicted to be suitable habitats.

RESULTS

Distribution and abundance estimates

Northern provinces

The maximum likelihood model of the breeding distribution of Little Bustards exhibited an AUC value above 0.75, indicating high confidence in the predictions (Figure 3). None of the 11 predictor variables was dropped from the final model. The model finds a higher probability of breeding Little Bustards across steppes and semi-deserts between the Ural river and the western border of Karaganda province. An additional high-likelihood area is predicted along the Irtysh river between the cities of Pavlodar and Semey in the east of the country.

The MaxSSS threshold, identifying areas suitable for the species (grey polygons in Figure 4), was calculated as 0.5. This 'predicted northern breeding distribution' encompasses 625 121 km^2, as measured in the Albers Equal Area Conic projection for North Asia. Generally, the predicted area corresponds well with breeding season observations of the species, including the recently published data that were not used in modelling. An exception is some areas to the north, which were not predicted to be suitable but where the species was recorded relatively recently. Conversely, some areas predicted as suitable are yet to yield any recent observations; these are areas on the border between West Kazakhstan and Aktobe provinces, the western part of Kostanay province and the northern part of Ulytau province (Figure 4).

Extrapolation of the mean breeding male density derived from the survey in central Kazakhstan (0.24 males per km^2; 95% CI, 0.14–0.39) to the area surveyed in that study (96 000 km^2) gives a rounded abundance value of 23 000 (95% CI 13 440–37 440) male Little Bustards during the breeding season, or around 32 000 breeding individuals assuming the 1:0.4 sex ratio. The survey area largely falls within the area predicted by the MaxEnt model, except for the northernmost survey plots. Extrapolating the density of breeding males in the survey area to the predicted northern breeding distribution gives a rounded estimate of 150 000 (95% CI, 87 500–243 800) breeding males and 210 000 (95% CI, 122 500–341 300) breeding individuals, assuming a 1:0.4 sex ratio.

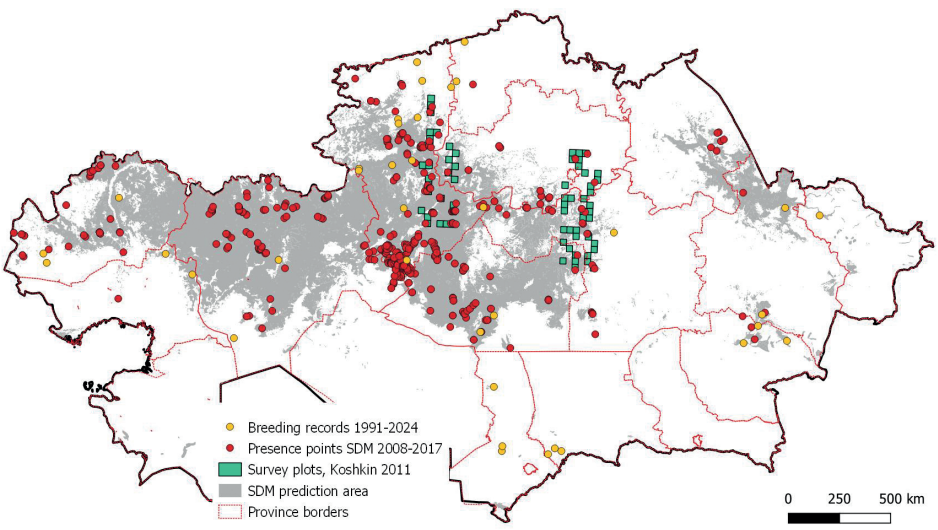

Figure 4. Breeding season records of Little Bustard in Kazakhstan from the published literature (yellow circles), presence points used for MaxEnt modelling (red circles), plots surveyed in 2011 (green squares, Koshkin 2011) and predicted northern breeding distribution for Little Bustard (grey).

Southern provinces

Based on the summed total of four local studies, the breeding population in the southern provinces of Kazakhstan is conservatively estimated at approximately 900 breeding individuals using a 1:0.4 sex ratio.

National estimate

By adding the estimate from the northern and southern breeding populations we obtain an estimate of breeding Little Bustard for the whole of Kazakhstan of 210 900 breeding individuals, with a possible range between 123 400–342 200 individuals (Table 2).

Table 2. Estimation of current Little Bustard abundance and population trends in the northern and southern regions of Kazakhstan. Population estimates during the migration season are not available owing to a paucity of records. Quality of estimate: 1 = low, 5 = high.

Region	Season	Number of birds	Important sites	Quality of estimate	Population trend			
					1950–1990	1990–2020	2020–2024	1950–2024
Northern	Breeding	122 500–341 300	20	3	↘	↗	↗	?
Southern	Breeding	900	3	3	↘	↗	?	?
Totals for Kazakhstan	Breeding	123 400–342 200	23	Average 3				

Threats and conservation measures

Land-use change represents one of the main threats to the Little Bustard in Kazakhstan. In many parts of its range, the species is confined to anthropogenic landscapes, suggesting that changes in agricultural practice or land use that are not compatible with the reproduction and survival of the species could lead to a decline in numbers. For example, a shift away from alfalfa cultivation in the southern provinces could lead to a decline in local populations that often nest successfully in or near these fields. Similarly, a shift to more intensive farming in the northern and central regions, where the species seems to benefit from abandoned arable land and hayfields, could potentially reduce its numbers. Considering that the Virgin Lands Campaign, a program of massive agricultural expansion in the second half of the 20th century, is recognised as a key factor influencing steep declines in Little Bustard populations (Gubin 2007, Kovshar' 2019), it is important to continue to monitor changes in land use across Kazakhstan's vast Little Bustard breeding grounds and the effects of these changes on the species.

The second threat, the impact of which likely varies greatly from region to region, is mortality from collision with powerlines. Although no specific studies have been carried out on the impact of powerlines on the Little Bustard in Kazakhstan, mortality data have been gathered incidentally during research focused on birds of prey. For example, during a survey of 680 km of powerlines in central Kazakhstan in 2012, the remains of five Little Bustards were found (Voronova *et al* 2012). In October 2023, during a survey of 140.9 km of transmission lines in West Kazakhstan province (within Bokeyorda State Nature Reserve and the Ashchyozek State Nature Reserve), the remains of four Little Bustards were found (RU unpubl data).

The third threat is poaching: limited anecdotal evidence from different parts of the species' range over the last 20 years confirms that illegal shooting of Little Bustards takes place. For example, in August 2001 a dead juvenile was found in the Alakol basin, probably killed by a poacher (Berezovikov & Anisimov 2013), and in October 2017

two Little Bustards were shot by hunters in Kostanay province (A Timoshenko pers comm). According to media reports, poachers who shot Little Bustards were detained in Kostanay province (www.time.kz; September 2009), in Aktobe province (www.diapazon.kz; September 2019) and in Jambyl province (www.365info.kz; October 2017). People in a vehicle were observed shooting a Little Bustard in Turkistan province outside any hunting season in 2017 (M Kessler pers comm). At the same time, it is important to note that the threat of poaching to the birds breeding in Kazakhstan is probably many times higher on wintering grounds to the south and in the Caucasus, where the species gathers in larger flocks. According to one estimate, an annual average of 30 000 Little Bustards are illegally shot in Azerbaijan alone (Brochet *et al* 2019). Despite the protected status of this species in Iran, illegal hunting of wintering birds is considered likely due to poor law enforcement (Sehhatisabet *et al* 2012).

DISCUSSION

We provide the first data-driven estimate of the abundance of the Little Bustard in Kazakhstan. Our estimate of 210 900 breeding individuals is significantly higher than the only previously published estimate for Kazakhstan (also including Kyrgyzstan) of 20 000 individuals in 2012 (BirdLife International 2018). Even at the time of its publication, the latter was probably a gross underestimate as it was based on information gathered before populations in North Eurasia had begun to recover. Observations of large wintering congregations, *eg* over 150 000 individuals in Azerbaijan (Gauger 2007), and a flock of 6000 in Jizzakh province of Uzbekistan (10 February 2024; Ten *et al* 2025, T Abduraupov pers comm), support our higher estimation.

However, our use of a sex ratio from a study in Europe and our application of the average density across vast areas of suitable habitat should be treated with care. In reality, the sex ratio is likely to vary between breeding sites in natural and agricultural areas, and between agricultural areas with different cultivation methods. There is also a possibility that the species may not have re-expanded across all suitable territories available in Kazakhstan.

Our estimate could be improved in several ways. The abundance assessment for northern regions of Kazakhstan assumes that the Little Bustard's density across northern Kazakhstan is equivalent to that measured at Koshkin's (2011) survey sites, which was an average across different habitat types surveyed. However, as densities can vary greatly by habitat type (Koshkin 2011), our abundance estimate could be improved if habitat-specific densities were extrapolated to the area of each habitat available within the predicted breeding area. Even more useful would be to carry out surveys in different parts of the range, particularly the north, west and south, to understand the species' densities at a finer scale.

Our assessment of abundance for southern regions of Kazakhstan is likely to be an underestimate, as the dataset from which we drew was small and did not cover the entirety of the range. However, there are no reasons to expect high numbers of breeding Little Bustards in the south due to limited suitable habitat. Consequently, the proportional contribution of the southern populations to the countrywide population estimate is likely to be very small.

Given that large migratory and pre-migratory aggregations of Little Bustards were recorded in the north and south of Kazakhstan in 2024 (as described in the Introduction), it is likely that the population continues to grow. However, some of these birds may originate from the bordering regions of Russia or Kyrgyzstan, with estimates of from *c*23 000–33 000 (Volga region; Oparin *et al* 2025) and *c*1500–2000 (Campeau *et al* 2025) breeding individuals respectively. Unless significant land-use changes occur, the upward population trend is

likely to continue or will stabilise soon. However, large-scale intensification of agriculture, reclamation of abandoned agricultural land and new areas of steppe could reverse the observed recovery, causing a rapid and significant decline in the species' numbers. Mortality from collisions with powerlines may increase with the expansion of the network as new oil sites open and green energy expands. The existing penalties for illegal shooting of the red-listed Little Bustard in Kazakhstan can be considered effective (around US$750 fine in 2024), as there is no evidence of large-scale poaching of Little Bustard in the country, despite its increase in numbers.

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LITERATURE CITED

Berezovikov, NN & EI Anisimov. 2013. [New data on Little Bustard *Tetrax tetrax* in Alakol depression.] *Russian Journal of Ornithology* 22(912): 2307–2308. [In Russian]

Berezovikov, NN & AS Feldman. 2015. [Return of the Little Bustard *Tetrax tetrax* to the steppes of Semipalatinsk Priirtysh'e.] *Russian Journal of Ornithology* 24(1096): 212–214. [In Russian]

BirdLife International. 2018. Species factsheet: Little Bustard *Tetrax tetrax*. Downloaded from https://datazone.birdlife.org/species/factsheet/little-bustard-tetrax-tetrax on 23/02/2025.

BirdLife International. 2025. Country profile: Kazakhstan. www.birdlife.org. Downloaded on 23/02/2025.

Birds.kz. 2024. Online database of the birdwatching community of Kazakhstan. https://kz.birding.day/.

Bragin, EA. 2019. [Little Bustard *Tetrax tetrax* and Great Bustard *Otis tarda* in the Kustanai region: population dynamics in the XX-XXI centuries.] *Russian Journal of Ornithology* 28(1757): 1705–1714. [In Russian]

Brochet, A-L, W van den Bossche, VR Jones, H Arnardottir, D Damoc, M Demko, G Driessens, K Flensted, M Gerber, M Ghasabyan, D Gradinarov, J Hansen, M Horváth, M Karlonas, J Krogulec, T Kuzmenko, L Lachman, T Lehtiniemi, P Lorgé, U Lötberg, J Lusby, G Ottens, J-Y Paquet, A Rukhaia, M Schmidt, P Shimmings, A Stipnieks, E Sultanov, Z Vermouzek, A Vintchevski, V Volke, G Willi & SHM Butchart. 2019. Illegal killing and taking of birds in Europe outside the Mediterranean: assessing the scope and scale of a complex issue. *Bird Conservation International* 29: 10–40.

Buckland, ST, SJ Marsden & RE Green. 2008. Estimating bird abundance: making methods work. *Bird Conservation International* 18(S1): S91–S108.

Campeau, LB, SV Kulagin & P Isayenko. 2025. Mapping the recovery of the Little Bustard *Tetrax tetrax* in Kyrgyzstan. *Sandgrouse* 47: 122–132.

Gauger, K. 2007. Occurrence, ecology and conservation of wintering Little Bustards *Tetrax tetrax* in Azerbaijan. *Archiv für Naturschutz und Landschaftsforschung* 46: 5–27.

Gavrin, VF. 1962. [Little Bustard.] *In*: *Birds of Kazakhstan* Vol. 2. Academy of Sciences of Kazakh SSR, Alma-Ata, pp12–26. [In Russian]

Gubin, BM. 2007. [Little Bustard.] *In: Birds of Central Asia*. Vol. 1. Kazakhstan Bird Protection Society, Almaty, pp391–394. [In Russian]

Gubin, BM. 2010 [Little Bustard.] *In: Red Book of Kazakhstan*. *Animals*. Vol. 1. Ed. 3. Almaty, pp164–165. [In Russian]

Gubin, BM. 2015. [Little Bustard.] *In: Birds of Deserts of Kazakhstan*. Vol. 1. Kolor, Almaty. [In Russian]

Gubin, BM. 2020. [Little Bustard.] *In: Birds of Deserts of Kazakhstan*. Vol. 3. Spring R, Almaty. [In Russian]

Gubin, BM & FF Karpov. 1994. [Current and associated behaviours of the Little Bustard in the foothills of the Lesser Karatau Mountains (Southern Kazakhstan).] *Selevinia* 1: 40–60. [In Russian]

Gubin, BM & FF Karpov. 1999. [Materials on nesting birds of Lake Bilikol (South Kazakhstan).] *Russian Journal of Ornithology* 75: 3–13. [In Russian]

Kamp, J, R Urazaliev, PF Donald & N Hölzel. 2011. Post-Soviet agricultural change predicts future declines after recent recovery in Eurasian steppe bird populations. *Biological Conservation* 144: 2607–2614.

Karpov, FF. 2008. [Autumn migration of Little Bustards in the interfluve of Turgen' and Issyk in 2007.] *Kazakhstan Ornithological Bulletin* 2008: 134. [In Russian]

Karpov, FF & BM Gubin. 1993. [Numbers and distribution of Little Bustards on the shore of Lake Bilikol (foothills of the Lesser Karatau).] *News of National Academy of Sciences of Kazakhstan* 6: 38–43. [In Russian]

Kolbintsev, VG. 2015. [New sightings of Little Bustard *Tetrax tetrax* in the foothills of the Karatau and Talas Alatau.] *Russian Journal of Ornithology* 24(1139): 1577. [In Russian]

Koshkin, M. 2011. Habitat preferences of steppe breeding birds in Central Kazakhstan, in relation to different forms of land use. MSc thesis. University of East Anglia.

Kovshar', AF. 2019. [Little Bustard.] *In: Birds of the Tien Shan*. Vol. 1. Almaty, pp319–321. [In Russian]

Oparin, ML, OS Oparina, AA Abushin, VN Fedosov & AA Nefedov. 2025. Status of Little Bustard *Tetrax tetrax* in Russia based on assessments in four key regions. *Sandgrouse* 47: 59–72.

Phillips, S. 2015. Maxent software for species habitat modelling. Version 08.2015. Available at: http://www.cs.princeton.edu/~schapire/maxent/.

Phillips, SJ & M Dudik. 2008. Modelling of species distribution with MAXENT: new extensions and a comprehensive evaluation. *Ecography* 31: 161–175.

Potapov, PL & VE Flint. 1987. [*Birds of the USSR: Galliformes, Gruiformes*.] Nauka, Leningrad. [In Russian]

Sehhatisabet, ME, F Abdi, A Ashoori, A Khaleghizadeh, A Khani, K Rabiei & M Shakiba. 2012. Preliminary assessment of distribution and population size of wintering Little Bustards *Tetrax tetrax* in Iran. *Bird Conservation International* 22: 279–287.

Serrano-Davies, E, J Traba, B Arroyo, F Mougeot, F Cuscó, S Mañosa, G Bota, N Faria, A Villers, F Casas, C Attié, P Devoucoux, V Bretagnolle & MB Morales. 2023. Biased adult sex ratios in Western Europe populations of Little Bustard *Tetrax tetrax* as a potential warning signal of unbalanced mortalities. *Bird Conservation International* 33: 40.

Shakula, VF, SV Shakula & GV Shakula. 2017. [Little Bustard—a natural component of agricultural landscapes of South Kazakhstan.] *In: Proceedings of the Conference 'Biosphere farming and sustainable development of rural areas'*. Ottisk, Irkutsk, pp 23–25. [In Russian]

Shevchenko, VL, PV Debelo, JI Gavrilov & AK Fedosenko. 1977. [Distribution and numbers of some rare bird species north of the Caspian Sea.] *In: Rare and Disappearing Animals and Birds of Kazakhstan.* Academy of Sciences of Kazakh SSR, Alma-Ata, pp17–20. [In Russian]

Shevchenko, VL, PV Debelo, EI Gavrilov, VA Naglov & AK Fedosenko. 1993. [On the avifauna of the Volga-Ural interfluve.] *In: Fauna and biology of birds of Kazakhstan.* National Academy of Sciences of the Republic of Kazakhstan, Almaty, pp7–103. [In Russian]

Soberon, J & AT Peterson. 2005. Interpretations of models of fundamental ecological niches and species' distributional areas. *Biodiversity Informatics* 2: 1–10.

Sorochinskii, MV. 2023. [Materials on the Little Bustard *Tetrax tetrax* in the North Kazakhstan region.] *Russian Journal of Ornithology* 32(2305): 2179–2183. [In Russian]

Starikov, SV. 2015. [Observations of Little Bustard *Tetrax tetrax* in the steppes of the Kalbinskii Plateau (Eastern Kazakhstan).] *Russian Journal of Ornithology* 24(1212): 4068–4069. [In Russian]

Swets, JA. 1988. Measuring the accuracy of diagnostic systems. *Science* 240: 1285–1293.

Ten, A, M Gritsina, T Abduraupov, E Kreuzberg, M Mitropolskiy, N Marmazinskaya & A Raykov. 2025. Warming temperatures and reduced snow cover are associated with new wintering grounds for the Little Bustard *Tetrax tetrax* in Uzbekistan. *Sandgrouse* 47: 133-139.

Vilkov, VS. 2014. [Little Bustard *Tetrax tetrax* nests again in the North Kazakhstan region.] *Russian Journal of Ornithology* 23(1088): 4165. [In Russian]

Voronova, VV, GI Pulikova, KK Kim, EV Andreeva, VR Bekker & T Aitbaev. 2012. [The impact of power lines on bird mortality in central Kazakhstan.] *Raptor Conservation* 24: 52–60. [In Russian]

Yakovlev, VA, AP Berber, NT Erzhanov, OA Rybalkina & DE Tuganov. 2016. [New data on the Great Bustard *Otis tarda*, Little Bustard *Tetrax tetrax* and Houbara Bustard *Chlamydotis undulata* in Central Kazakhstan.] *Russian Journal of Ornithology* 25(1367): 4522–4526. [In Russian]

Zhang, X, L Liu, X Chen, Y Gao, S Xie & J Mi. 2021. GLC_FCS30: global land-cover product with fine classification system at 30 m using time-series Landsat imagery. *Earth System Science Data* 13: 2753–2776.

Zuban, IA, AY Timoshenko, PS Dmitriyev, SN Gashev, MN Kalashnikov, BM Suindykov, VS Lunyov & SV Shnel. 2025. Review of rare bird species in the North Kazakhstan: update and additions to the regional avifauna list. *Acta Biologica Sibirica* 11: 223–248.

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