Recovery at risk: a flyway-level population assessment of the Little Bustard *Tetrax tetrax* in its eastern range

MIMI KESSLER, LOUIS-PHILIPPE CAMPEAU & NIGEL J COLLAR

Summary: National extinctions have divided the Near Threatened Little Bustard *Tetrax tetrax* into a western range focused on Iberia and a much broader eastern range, from Crimea to westernmost Xinjiang, China, where the (almost entirely migratory) population is larger but national status and trends are in varying degrees uncertain. Drawing primarily on the 16 geographically oriented contributions to this special section in *Sandgrouse*, four general flyways in the eastern range can be identified (numbers below refer to breeding individuals). The Black Sea flyway, currently mainly involving Crimea and Türkiye, appears to possess only 100–120, with a long-term downward trend suggesting imminent extirpation, expanding the existing divide between the western and eastern ranges. The Caucasus flyway holds 69 850–128 150 mature individuals (not including young-of-year), to which Russia (North Caucasus, Volga region and Orenburg) contributes 43 850–55 750 and north-west Kazakhstan (west of the Emba river) 26 000–72 400. Populations within this flyway exhibit mixed trends likely owing to the patchy distribution of agricultural re-intensification, but a decline is expected as powerlines proliferate, especially in the wintering grounds of Azerbaijan. The Turkestan flyway presents a problem in which total breeding numbers (to which Russia, Kazakhstan and Kyrgyzstan chiefly contribute) are estimated to be much higher than wintering numbers (spread across Uzbekistan, Tajikistan, Turkmenistan and Iran). Precautionarily, we propose a range of 24 740–50 000 mature breeding birds in this flyway, with mixed trends but a decline expected as powerlines proliferate. The South Asia flyway, known only by its staging (Iran) and wintering (Afghanistan and Pakistan) areas, may retain as few as 10–50 breeding individuals and is feared close to extirpation. The eastern range of the Little Bustard thus consists of an estimated 94 700–178 320 breeding birds, of which Azerbaijan hosts the great majority in winter. Populations within the eastern range now account for 62–65% of an estimated global total of 146 000–288 000 individuals. Key threats are illegal hunting, particularly when targeting large flocks in the wintering grounds (especially in Azerbaijan); increased breeding failure, female mortality and habitat degradation associated with agricultural re-intensification (notably in Kazakhstan and the Volga region of Russia); rapidly proliferating powerlines associated with renewable energy development; the disruptive effects on survival, reproduction and distribution of global warming (albeit there may be some benefit from reduced migration distances); and inadequate investment in scientific research and management resources by which to identify and implement appropriate conservation measures.

INTRODUCTION

The global range of the Little Bustard *Tetrax tetrax* once stretched almost continuously across the steppes and farmland of Mediterranean North Africa, Europe and Asia, from Portugal and Morocco in the west to Xinjiang, China, in the east. Over the past 130 years, a series of extinctions in range states in central, eastern and south-eastern Europe as well as North Africa (detailed in Morales & Bretagnolle 2022b) have resulted in a rift of approximately 2000 km separating populations in western Europe from others in eastern Europe and Central Asia, with the species consequently assigned the IUCN threat category of Near Threatened (BirdLife International 2018).

To the west, Little Bustards in Iberia, France, and a fragile remnant population in Sardinia, Italy (henceforth 'western range' or 'western population') are estimated to comprise 51 194–109 959 individuals (Morales & Bretagnolle 2022a). Everywhere in this range the species is in serious decline, with the countries with the largest populations exhibiting the largest declines—48% in 11 years in Spain, and 49% in 13 years in Portugal (sources in Morales & Bretagnolle 2022a). The number of birds remaining from Crimea and eastern Türkiye eastwards (henceforth 'eastern range' or 'eastern population'), including an east–west expanse of steppes stretching 4000 km, has proved more challenging to estimate, and the trends more complicated. Using primarily figures from 2017 (Collar *et*

al 2017) along with updates from Russia and Ukraine (*eg* Oparin *et al* 2018), Morales & Bretagnolle (2022a) arrived at a total of 38 000–142 200 individuals in the breeding grounds of the eastern population. Here we take the opportunity to revisit the status of the species in its eastern range by drawing on information from papers published contemporaneously in this *Sandgrouse* special section, using flyway-level analyses to construct a contemporary population estimate.

FLYWAYS WITHIN THE EASTERN RANGE

No satellite telemetry has been undertaken on Little Bustards within their eastern range. However, ornithological observations have been recorded across this region for well over 150 years, beginning with expeditionary work during the Russian and British imperial eras and continuing with research undertaken during the early Soviet period. These studies are important, as they pre-date the large-scale collapse of Little Bustard populations during the second half of the 20th century. Through a review of this literature, as well as the articles within this *Sandgrouse* special feature, we propose four main migratory pathways used by Little Bustards within their eastern range and outline present population figures within each of them. Listed from west to east, these comprise: the Black Sea flyway, the Caucasus flyway, the Turkestan flyway, and the South Asia flyway (Figure 1).

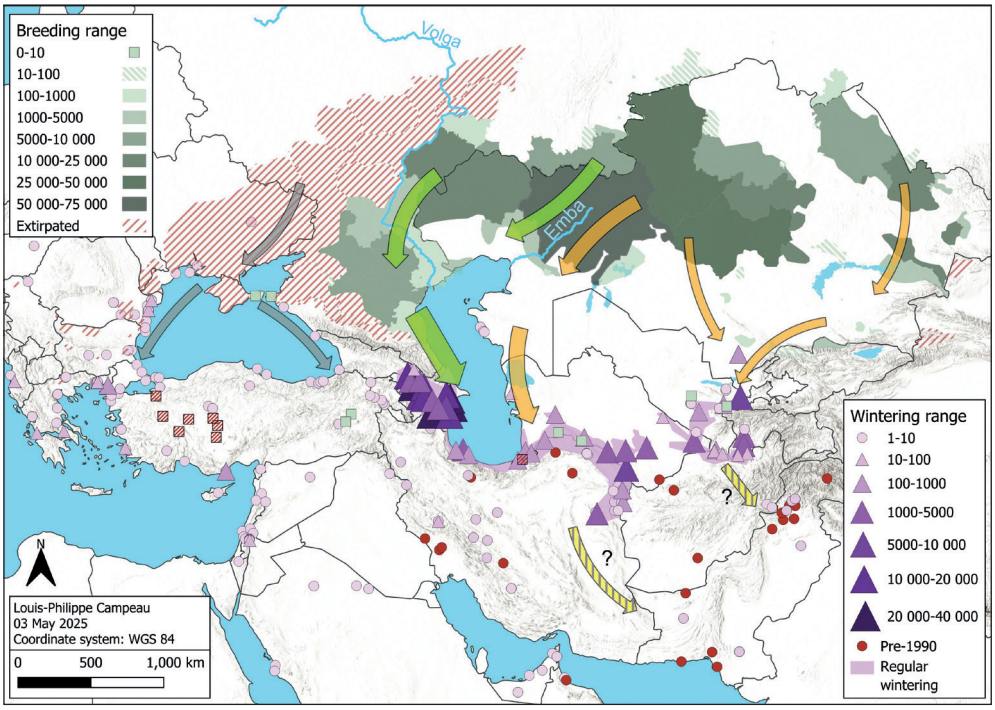

Figure 1. Four major Little Bustard flyways represented by arrows (Black Sea in grey, Caucasus in green, Turkestan in orange and South Asia in hatched yellow; width indicates relative number of birds within the flyway) superimposed on their breeding range (green for extant and hatched indicating extirpated) and wintering sites (purple triangles, sized and shaded in relation to the number of birds using the site). Purple dots indicate single winter records and red dots pre-1990 observations. Sources: population tables from all 16 geographically oriented contributions in *Sandgrouse* 47; for areas of outside of this review: Averin *et al* (1971), Scherbak (1994), Gao *et al* (2008), Papakonstantinou *et al* (2009), Boev (2015), Radišić *et al* (2018).

Black Sea flyway

The widening of the gap between western and eastern populations of Little Bustards has resulted in smaller numbers of birds using this flyway. Although extirpated as a breeding species from continental Ukraine, Moldova, Romania, Bulgaria, Serbia and Greece (Morales & Bretagnolle 2022b), small breeding populations persist in Crimea, eastern Türkiye and the Taman' peninsula of Russia's Krasnodar krai (Andryushchenko 2009, Kostin 2015, Til'ba 2024, Özgencil *et al* 2025). Now extirpated, Little Bustards that bred along the Don river, north of the Azov Sea, and in Russia's Central Black Earth (Chernozem) region, migrated west and south-west to Crimea (Isakov & Flint 1987). From there, further movements could be undertaken along the western shore of the Black Sea (Menzbir 1934), passing through south-western Ukraine (Kandaurov 1992), Romania (Ministry of Environment Water and Forests 2022), and into Greece (Athanasios 2023), where these birds sometimes remain throughout the winter (Dimitris Kokkinidis in litt) or pass onward into Thracian Türkiye (Özgencil *et al* 2025). A second pathway along the eastern Black Sea coast brings Little Bustards through western Georgia (Til'ba 1999, Til'ba & Lokhman 2007) and into eastern Türkiye (Özgencil *et al* 2025). The observation of an individual arriving at Ordu from the sea (Özgencil *et al* 2025), as well as the species' past winter visits to Cyprus (Flint & Richardson 2024; last recorded in 2017), indicate that the Little Bustard is not constrained to overland flights.

Although Türkiye represents the usual southernmost limit of overwintering Little Bustards within this flyway, overshoots and irruptions, particularly of females and juveniles (Campeau & Kessler 2025), irregularly reach further south (and even south-west: Plate 1). In addition to visits to Cyprus, Little Bustards have occasionally reached the Nile delta (Goodman & Meininger 1989; last recorded in 1922). They are intermittently recorded in Iraq and the Levant (Aidek *et al* 2025), Israel (Perlman 2025) and the Arabian peninsula (Campbell & Kessler 2025). Hunting pressure in these areas is high, and hunters' social media photos account for the majority of records.

Plate 1. Little Bustards over İzmir, Türkiye, 5 February 2025. © *Alphan Anak*

Table 1. Numbers of mature Little Bustards estimated at breeding grounds within the Black Sea flyway, ordered north to south. N/A = not applicable. 'Status' refers to the Red List assessment at the geographic unit relevant to the source cited within the table; CR = Critically Endangered; EN = Endangered; EX = Extinct. Quality of assessment was evaluated by the author of the source cited, on a scale from 1 (few data available) to 5 (repeated surveys). ↘ = declining, ↗ = increasing, † = extirpated.

Territory	Min	Max	Quality	Status	Trend 1950–1990	Trend 1990–2020	Trend 2020–2023	Trend 1950–2023	Source
Crimea	10	14	N/A	CR	↘	↘	↘	↘	Lokhman 2017, Til'ba 2024
Krasnodar	6	10	N/A	EN	↘	↗	↘	↘	Andryushchenko 2009, Kostin 2015
Moldova	0	0	N/A	EX	†	†	†	†	Averin *et al* 1971
Romania	0	0	N/A	EX	↘	†	†	†	Min. Environment 2022
Serbia	0	0	N/A	EX	†	†	†	†	Radišić *et al* 2018
Bulgaria	0	0	N/A	EX	†	†	†	†	Boev 2015
Greece	0	0	N/A	EX	↘	†	†	†	Athanasios 2023
Türkiye	10	20	3	CR	↘	↘	↘	↘	Özgencil *et al* 2025
Syria	0	0	3	†	↘	†	†	†	Aidek *at al* 2025
Summary:	**26**	**44**							

Table 2. Minimum number of wintering Little Bustards, and largest flocks of the species recorded at migratory stopover and wintering areas within the Black Sea flyway, ordered north to south. See Table 1 for further explanations. Little Bustards are also observed in the Levant, Iraq and the Arabian peninsula, but irregularly and in low numbers.

Territory	Winter minimum	Largest non-breeding	Quality of estimate	Status	Sources	Notes
Crimea	0	23	N/A	CR	Kostin 2015	Largest single flock
Krasnodar	0	0	N/A	EN	Til'ba 2024	Last noted in 1980s to 1990s
Georgia	100	200	3.8	VU	Gov. Georgia 2014, Budagashvili 2025	
Romania	0	20	N/A	EX	Min. Environment 2022, Campeau & Kessler 2025	
Bulgaria	0	10	N/A	EX	Boev 2015	National winter estimate
Greece	0	258	N/A	DD	Athanasios 2023, Campeau & Kessler 2025	Largest flock 258, Thrace
Türkiye	100	400	3	CR	Özgencil *et al* 2025	Largest flock 100–120 individuals, Göksu Delta IBA
Black Sea flyway	**200**					

Black Sea flyway population estimate

Sources from 2015 to 2024 tally only 26–44 Little Bustards on breeding grounds in the Black Sea flyway and register a decreasing trend over past decades (Table 1). However, larger numbers are occasionally observed on migratory stopover and wintering grounds within the flyway (Table 2). To determine whether the largest flocks observed in Greece and western Georgia (maximum of 258 and 200 individuals respectively, Table 2) are consistent with the numbers reported on breeding grounds to their north (16–24 individuals in Crimea and Krasnodar, Table 1), we assume a sex ratio of 1:1 (see 'Caucasus flyway population estimate' for why this might be optimistic) and thus 8–12 females on the breeding grounds. If we presume that each female produces a fully successful clutch of 4 eggs (3–4 eggs were reported as typical clutch sizes in this region: Andryushchenko 2009, Kostin 2015, Savitskii 2024), then theoretically 32–48 young could be produced each year, for a total of 40–60 female-type (females and juveniles) or 48–72 Little Bustards of both sexes by the time of autumn migration. The observation of aggregations of predominantly female-type Little Bustards somewhat larger than this in Greece and Georgia (Table 2; Campeau & Kessler 2025) suggests that either some breeding birds in the northern part of this flyway may be undercounted, some breeding sites are unreported, or some birds breeding to the north-east may occasionally use the Black Sea flyway from unknown causes. Indeed, a movement of some individuals between Azerbaijan's Kura steppe and coastal Georgia (suggested by Isakov & Flint 1987) could account for some 'excess' Little

Bustards in Georgia and Türkiye, but not for the larger flock observed in Greece. For this reason, we estimate the breeding population of Little Bustards at 100–120 individuals, somewhat higher than the sum of the known breeding populations.

Black Sea flyway trends

Population growth, even assuming high annual productivity, is likely to be constrained by mortality along the migratory pathway for young-of-year and females undertaking longer-distance migrations (Campeau & Kessler 2025). A trend towards continued erosion of the western border of the eastern range of Little Bustards, described earlier for eastern European populations by Collar (1978) and Kandaurov (1992), is observed (Figure 1). Breeding populations in Syria were gone by the 1950s (Aidek *et al* 2025), while those in eastern Ukraine declined to the point of total extirpation by the 1990s (Andryushchenko 2009). Populations in western portions of Russia's Krasnodar and Stavropol' krais, Rostov and even Saratov oblast's were extirpated during the 2000s (Khokhlov & Il'yukh 2013, Lokhman 2017, Savitskii 2024, Til'ba 2024).

Caucasus flyway

Populations of Little Bustards breeding along the middle and lower Volga river, as well as the western Caspian lowlands, are known to migrate south into the Caucasus (Bliznyuk 2018). Further east, however, the geographical divide between breeding populations migrating into the Caucasus and those migrating along the eastern Caspian coastline is unknown. A number of distinguished naturalists have surmised the routes of Little Bustards in this region, based on their field observations of migratory flights. Their suppositions include (ordered roughly from west to east, and referring to contemporary political boundaries):

- Birds follow the middle and lower stretches of Kazakhstan's Ural river and continue southwards through Kazakhstan and Turkmenistan along the eastern coast of the Caspian Sea (Sushkin 1908).
- Conversely, individuals flying south along the Ural river continue along the western Caspian coast towards the Caucasus (Isakov & Flint 1987).
- Birds move to the south-east between the Uil and Emba rivers on the eastern border of Atyrau province, Kazakhstan (A Nechaev, as referenced in Fedosov 2019).
- Birds from Orenburg oblast' (Russia) and West Kazakhstan province (Kazakhstan) move south-west to reach Russia's Astrakhan' oblast' (Bliznyuk 2018).
- Birds migrate south-west along the Or' river to the Emba (Aktobe to Atyrau province, Kazakhstan) and then southwards along the eastern Caspian (Sushkin 1908).
- Birds follow the Irgyz (eastern Aktobe province, Kazakhstan) and Turgai (southern Kostanay province, Kazakhstan) rivers, and then move southwards to reach the Syr Darya, south-west Kazakhstan (Sushkin 1908).
- Birds breeding in western Kazakhstan, and some breeding in northern Kazakhstan, reach the eastern coast of the Caspian and follow it southwards to the Atrek valley; others breeding in northern Kazakhstan fly along the Sarysu or cross the central Kazakhstan hill country, well east of the Aral Sea (Isakov & Flint 1987).
- Birds breeding in northern Kazakhstan primarily fly south-west, passing to the north of the Aral Sea and across the Ustyurt plateau (western Kazakhstan/Uzbekistan) to reach the eastern coast of the Caspian, then turn southwards to Turkmenistan (Dement'ev 1951).
- Birds breeding in northern Kazakhstan fly to the south-west; some round the north Caspian to fly south along its western shore, others fly through the Ustyurt plateau (Gavrin 1962).

- North–south migrations in Kazakhstan are noted in the provinces of Mangystau and Atyrau, Turkistan and Aqmola (Gubin 2010, 2020), as well as Kostanay (Ryabov 1949).
- On spring migration, birds move north-eastwards across the Kyzylkum desert (stretching between Uzbekistan and Kazakhstan: Gubin 2020).

Some of these routes contradict each other and telemetry studies will be necessary to establish the true movement patterns of Little Bustards between the Caucasus and Turkestan flyways. Nevertheless, a few conclusions can be drawn from these statements. First, across Kazakhstan the species exhibits a general tendency towards south-westwards autumn migration. Second, east of Aktobe province a greater number of subpopulations are described as moving along the eastern Caspian coastline than along the western. With these general observations, we propose a migratory divide roughly along the course of the Emba river, from the north-west Caspian through Aktobe province to the southern end of the Ural mountains. This hypothesised migratory divide results in approximately 21% of the northern distribution of Little Bustards within Kazakhstan (132 611 km^2, measured in the Albers Equal Area Conic projection for North Asia), as described by Koshkin *et al* (2025), belonging to the Caucasus flyway.

Caucasus flyway population estimate

Using the density estimates in Koshkin *et al* (2025), Little Bustards breeding in Kazakhstan and using the Caucasus flyway are estimated to be in the range of 26 000–72 400 individuals (Table 3). Combined with breeding numbers in the Russian North Caucasus, Volga region and Orenburg, the total population of Little Bustards breeding within the Caucasus flyway reaches 69 850–128 150. Sex ratios on these breeding grounds have been hazarded as 1:0.4 for Kazakhstan (*ie* 2.5 males per female; Koshkin *et al* 2025) and 1:0.8 for the Russian Federation (Oparin *et al* 2025); thus we expect approximately 26 900–45 500 females, a significant proportion of which would not produce successful clutches owing to the same factors that probably depress the sex ratio: the destruction of nests and sometimes also females by agricultural harvesting machinery.

The minimum total number of wintering birds within this flyway is estimated at 81 995, which is approximately 17% more than the minimum breeding population within the flyway, and 56% less than the maximum breeding population (Table 4). Within the Caucasus, Little Bustards are observed to cross international borders frequently (*eg* between Georgia and Azerbaijan: Budagashvili 2025, Farajli 2025), and to move in response to weather, resource availability and disturbance, rather than remaining on the same wintering grounds throughout the season. The resulting possibility of double-counting renders it inappropriate to sum the maximum wintering values for each country. Conversely, some wintering flocks may be missed due to nocturnal migration through the Beshbarmag bottleneck, or incomplete monitoring. However, it is of considerable interest that, following intensive surveys in January–February of 2024 and 2025, Farajli's (2025) estimate of 175 296 individuals in Azerbaijan, long known to host far larger numbers than Georgia, is 37% higher than our estimated maximum breeding population. Winter flocks will, of course, include young-of-year not counted within breeding population surveys, and which may not survive to return to the breeding grounds. The maximum winter estimate from Azerbaijan would be consistent with conditions of modest reproductive success within the posited breeding population: an average fledging of 1–2 chicks per female, or the hatching of a full clutch of four young for about half the breeding females. Thus, using a migratory divide along the Emba river to the southern Ural mountains, we propose a breeding population of 69 850–128 150 mature Little Bustards within the Caucasus flyway. This number does not include young-of-year, which would of course be included in winter counts in Azerbaijan.

Table 3. Numbers of mature Little Bustards estimated at breeding grounds within the Caucasus flyway, ordered north to south. See Table 1 for further explanations. VU = Vulnerable; EN = Endangered. *Estimate excludes birds in the Taman' peninsula of Krasnodar krai, which are counted in the Black Sea flyway (Table 1). **For provincial level Red List assessments within North Caucasus and Volga regions, see Oparin *et al* (2025). ***The status is VU both at the Russian national and Orenburg oblast' level of assessment.

Country	Region	Min	Max	Quality of estimate	National status	Trend 1950–1990	Trend 1990–2020	Trend 2020–2023	Trend 1950–2023	Source
Russia	North Caucasus*	11 100	13 100	3.8	VU**	↘	↗	no data	↗	Oparin *et al* 2025
Russia	Volga region	22 750	32 650	3.6	VU**	↘	↗	↘	↘	Oparin *et al* 2025
Russia	Orenburg	10 000	10 000	3.3	VU***	↘	↗	no data	↘	Oparin *et al* 2025
Kazakhstan	West of Emba river	26 000	72 400	3	EN	↘	↗	↗	?	Koshkin *et al* 2025
Summary:	**Caucasus flyway**	**69 850**	**128 150**	**Ave: 3.4**						

Table 4. Numbers of Little Bustards estimated at wintering grounds within the Caucasus flyway, ordered north to south. See Table 1 for further explanations. VU = Vulnerable; NT = Near Threatened. *These are recent data for non-breeding birds. **For provincial level Red List assessments within North Caucasus and Volga regions, see Oparin *et al* (2025).

Country	Region	Winter minimum	Largest numbers	Quality of estimate	National status	Source	Notes
Russia	North Caucasus	300	300	3.8	VU**	Oparin *et al* 2025	
Russia	Volga region	10	10	3.6	VU**	Oparin *et al* 2025	
Georgia	Entire country	1000	70 000	4	VU	Budagashvili 2025	Wintering population maximum estimate
Armenia	Entire country	10	100	3	VU	Aghababyan 2025	Migratory stopover, none in winter
Azerbaijan	Entire country	65 650	175 296	4.2	NT	Farajli 2025	Largest number is from intense country-wide survey
Iran	North-west	15 025	35 080	2.5	Protected	Ashoori *et al* 2025	Wintering population maximum estimate
Summary:	**Caucasus flyway**	**81 995**		**Ave: 3.5**			

Caucasus flyway trends

Trends in both breeding and wintering populations of the Caucasus flyway during recent decades are mixed, with some regions experiencing increases and others decreases. Adverse breeding conditions associated with agricultural transition, both in terms of cultivation and numbers of livestock, have significantly constrained breeding populations west and south of the Volga river (Oparin *et al* 2025), but seem to have limited impact for now in western Kazakhstan, where the agricultural economy has been slower to revive. Threats noted within this flyway include the destruction of eggs, young and females by farm machinery on the breeding grounds (Koshkin *et al* 2025, Oparin *et al* 2025), and poaching in Azerbaijan (Collar & Kessler 2021, Farajli 2025) and Iran (Yousefi *et al* 2017, Ashoori *et al* 2025). In Georgia, habitat loss through afforestation is associated with degradation of remaining steppelands through overgrazing (Budagashvili 2025), and fragmentation from urbanisation and agriculture reduces habitats for this species in Armenia (Aghababyan 2025). Significantly increased mortality rates can be expected with the dramatic current expansion of powerline networks, *eg* the World Bank's AZURE investment (World Bank 2024). This project proposes over 700 km of new transmission lines, including lines perpendicular to major Little Bustard migratory movements, planned south of the Beshbarmag bottleneck, adjacent to the Mingechevir reservoir, and encircling the terrestrial boundaries of the important wintering site of Shirvan National Park (Plate 2). As a consequence, a decreasing percentage of the wintering population can be expected to return to breeding grounds in coming years.

Plate 2. Little Bustards at Shirvan National Park, Salyan, Azerbaijan, in the Caucasus flyway, 7 March 2023.
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Turkestan flyway

As discussed under 'Caucasus flyway', Little Bustard migration through the east Caspian coastlands has long been recognised, with the birds going to winter in Turkmenistan's

Atrek river delta and Iran's eastern Caspian lowlands. Further east, Little Bustards breeding across western Siberia and northern Kazakhstan are observed to fly south, and then south-west once reaching the northern extent of the Tian Shan, passing through Uzbekistan to overwinter there or in Turkmenistan, Iran, Tajikistan and possibly Afghanistan north of the Hindu Kush (Gavrin 1962, Gubin 2007). This flyway would have formerly encompassed the most eastern reaches of the eastern range of Little Bustards in western China, the species now being noted only during some autumns in western Xinjiang's Tacheng prefecture (Xu & Ma 2016). Determining the proportion, and breeding sites, of birds within the Turkestan flyway that use the eastern Caspian pathway as opposed to migrating towards the foothills of the Tian Shan will require further research.

Turkestan flyway population estimate

Breeding population estimates within this flyway produce a total of 104 094–277 139 individuals, with northern Kazakhstan accounting for over 90% of this number (Table 5). However, the sum of known wintering populations, which is likely to be an overestimate (due to double-counting of mobile winter flocks), yields 16 225–24 740 Little Bustards (Table 6). This number reflects only 9–16% of the estimated breeding population, with *c*88 000–252 000 breeding birds unaccounted for on the wintering grounds, a number that does not yet take into consideration young-of-year birds undertaking their first autumn migration. We suggest several likely overlapping explanations for this discrepancy between breeding and wintering grounds, relating to (1) method of estimation, (2) possibility of uncounted winter flocks, and (3) our choice of a migratory divide at the Emba river.

Owing to a lack of survey information in northern Kazakhstan, the Little Bustard breeding population there had to be extrapolated from density calculations at well-surveyed sites in central Kazakhstan to an area of suitable habitat over 620 000 km² (Koshkin 2011, Koshkin *et al* 2025). A combination of factors might explain why such extrapolation would produce an overestimate. Little Bustard densities are uneven across this region (*eg* Shevchenko *et al* 1993), perhaps owing to variation in climatic suitability, productivity, wildfire regimes, predator densities or other natural factors. Moreover, farmland reclamation has proceeded unevenly after the mass agricultural abandonment of the post-Soviet economic transition, with higher-yielding farmland closer to transportation networks reclaimed earlier than lower-producing farmland, some of which is not viable in the free-market economy (Dara *et al* 2018, Baumann *et al* 2020). Finally, in areas of northern Kazakhstan where post-1950 declines took the species to the point of extirpation (Zuban *et al* 2025), some Little Bustard populations may still not have recovered the full extent of their available ecological niche.

In contrast, on wintering grounds in Iran, Tajikistan and Turkmenistan, estimates have been obtained through standard annual large-scale surveys over long time-frames (Ashoori *et al* 2025, Muratov 2025, Rustamov & Shcherbina 2025), which would seem less likely consistently to miss large numbers of wintering birds. Nevertheless, the Turkestan flyway differs from the others above in lacking a bottleneck at which birds can more readily be censused. Furthermore, survey effort has been low in areas of Uzbekistan and northern Afghanistan. The calculation presented above compares estimates on breeding and wintering grounds by subtracting the aggregated winter survey results from the extrapolated prediction for the breeding population in northern Kazakhstan, resulting in a striking disparity that challenges the plausibility of the breeding estimates. However, we also tested the plausibility of the winter survey results by deriving from them the highest possible breeding numbers, using two extreme assumptions. The first is that no chicks from northern Kazakhstan survive to fledging. This is because any numerical allowance for juveniles in the wintering population subtracts from the number of adults that

constitute the breeding pool. The second is that no other breeding sites contribute birds to the wintering grounds. This is because any wintering adult attributed to a different breeding range again lowers the number of adults attributable to northern Kazakhstan. The resulting summed total of winter maxima is 24 740 (Table 6). However, this artificially inflated number is still lower than the 32 000 breeding individuals estimated for the higher-intensity survey conducted over a 96 000 km^2 area of Central Kazakhstan (Koshkin *et al* 2025), let alone for the full breeding extent of this flyway within northern Kazakhstan. Clearly this suggests there are limitations to the relatively rigorous and exhaustive winter surveys and underscores the need for increased spatial and temporal coverage of the target areas—ideally synchronised to avoid double-counts or missed flocks—as well as expanded surveys in northern Kazakhstan to identify regions of greater and lesser breeding densities.

We also consider it possible that the migratory divide between the Caucasus and Turkestan flyways lies further east than we have proposed at the Emba river. Alternatively, there may be no static dividing line, with Little Bustards rather moving through one or the other flyway depending on weather, resources or other factors. These scenarios would have the effect of increasing the number of breeding birds in the Caucasus flyway, thus implying a deficit of uncounted Little Bustards on that flyway's wintering grounds. This would also lessen, but not eliminate, the deficit of Little Bustards in the wintering grounds of the Turkestan flyway.

Given the available data, there will necessarily be large uncertainties associated with any estimation of the population of Little Bustards within the Turkestan flyway. As a precautionary measure, we elect to use the maximum sum of known wintering populations—24 740 mature individuals—as a minimum estimate for the breeding population. To sum wintering counts risks overestimation due to double-counting, but we consider that the number chosen compensates for the likelihood of unknown and unsurveyed wintering sites. As a maximum estimate for the breeding population, we double this figure to obtain approximately 50 000 mature individuals, a number that logic suggests is more plausible in light of our analysis above.

Turkestan flyway trends

Recent population trends on breeding grounds within the Turkestan flyway are mixed, with both increases and decreases recorded over the past decade. Numbers wintering in Iran were increasing in the 2010s, but seem to have reached a plateau (Yousefi *et al* 2017, Ashoori *et al* 2025). In Turkmenistan, large-scale irrigated farmland in inland river deltas and along foothills, combined with the replacement of cotton by cultures more friendly to Little Bustards such as cereals and alfalfa, supports larger wintering populations (Rustamov & Shcherbina 2025). Trends on the wintering grounds also appear to reflect a response to climate change. Wintering birds are now observed further north (as noted in Uzbekistan by Ten *et al* 2025; Plate 3), while numbers at the most southerly sites (in Iran) are decreasing (Ashoori *et al* 2025). A similar northward shift of wintering grounds has been described for Great Bustards *Otis tarda* in Central Asia (Kessler & Smith 2014). However, a corresponding northward shift of breeding areas has not been described for either species.

The major threat identified on the wintering grounds is poaching, which can prevent birds from establishing regular use of a site as hunters learn of their presence (*eg* in Tajikistan; Muratov 2025) or force them into safer border areas (*eg* in Iran; Yousefi *et al* 2017). On the other hand, a *de facto* hunting ban in Turkmenistan since 2018 has eased concerns of poaching there (Rustamov & Shcherbina 2025). Worryingly, major energy developments along the Turkestan migratory flyway can be expected to increase rates of mortality if

Table 5. Numbers of mature Little Bustards estimated at breeding grounds within the Turkestan flyway, ordered north to south. See Table 1 for further explanations. EN = Endangered, VU = Vulnerable, NT = Near Threatened, DD = Data Deficient. *Does not include Orenburg, which is accounted in the Caucasus flyway. **For provincial level Red List assessments within North Caucasus and Volga regions, consult Oparin *et al* (2025).

Country	Region	Min	Max	Quality of estimate	Status	Trend 1950–1990	Trend 1990–2020	Trend 2020–2023	Trend 1950–2023	Source
Russia	Urals*	5010	5020	3	VU**	↘	↗	?	↘	Oparin *et al* 2025
Russia	Western Siberia	150	320	3	VU**	absent	↗	↗	↗	Oparin *et al* 2025
Kazakhstan	N Kaz, E of Emba river	96 532	268 910	3	EN	↘	↗	↗	?	Koshkin *et al* 2025
China	Entire country (Xinjiang)	0	0	N/A	DD	↘	↘	† (as breeder)	†	Gao *et al* 2008
Kazakhstan	Southern isolated pops	900	900	3	EN	↘	↗	?	?	Koshkin *et al* 2025
Uzbekistan	Entire country	2	10	1	VU	↘	↘	↘	↘	Ten *et al* 2025
Kyrgyzstan	Entire country	1496	1965	3	NT	↘	↗	possibly →	↗	Campeau *et al* 2025
Turkmenistan	Entire country	4	4	5	not listed	→ to ↘	↗	↗	↗	Rustamov & Shcherbina 2025
Iran	NE Iran	0	10	1	protected	no data	possible ↘	possible ↘	possible ↘	Ashoori *et al* 2025
Summary: Turkestan flyway		**104 094**	**277 139**	**Ave = 2.8**						

Table 6. Numbers of Little Bustards estimated at wintering grounds within the Caucasus flyway, ordered north to south. See Table 5 for further explanations.

Country	Region	Winter Min	Winter Max	Quality of estimate	Status	Trend 1950–1990	Trend 1990–2020	Trend 2020–2023	Trend 1950–2023	Source
Uzbekistan	Entire country	6500	7500	2	VU	↘	↗	↗	↗	Ten *et al* 2025
Tajikistan	Entire country	535	2270	4.3	NT	N/A	↗	↗ + ↘	↗	Muratov 2025
Turkmenistan	Entire country	5440	9470	3.6	not listed	→ to ↘	↗	↗	↗	Rustamov & Shcherbina 2025
Iran	NE Iran	3750	5500	3	protected	N/A	↗	↘	↘	Ashoori *et al* 2025
Summary: Turkestan flyway		**16 225**	**24 740**	**Ave = 3.2**						

mitigation is insufficient (see, *eg*, Plate 3). These include the Kungrad project, involving an 800 km transmission line perpendicular to migratory pathways (Asian Development Bank [ADB] project 57342; Collar & Kessler 2024); Samarkand 1 & 2 (ADB projects 58290 & 58291, www.adb.com); and the Hyrasia project in Kazakhstan's Mangystau province (hyrasia.one). Meanwhile, the impact of current agricultural practices on productivity and female mortality in this flyway is almost totally unknown, and is likely to differ significantly across the wide breeding range.

South Asia flyway

The least documented region within the eastern range of the Little Bustard is South Asia, where the species is observed to winter in the northern (Khyber Pakhtunkhwa) and southern (Balochistan and Sindh) regions of Pakistan (Khan *et al* 2025). Birds presumably reach these areas by transiting through adjacent provinces of Afghanistan (Kandahar and Nangarhar, respectively), where the species has also been observed in winter (Ostrowski 2025). Historically, the Little Bustard was considered a regular and 'tolerably abundant' winter visitor to the Punjab west of the Indus, where it was a target for hunters and falconers who could kill up to a dozen per day, and a vagrant in what is now India (Hume & Marshall 1879). Sarudny (1911) noted Little Bustards overwintering as far south as Sistan and Baluchistan in south-eastern Iran; a relatively short flight from these regions could explain some of the historical records in Pakistan's Balochistan province. Since 1990, there have been four or fewer individuals noted per winter in Afghanistan and Pakistan (Khan *et al* 2025, Ostrowski 2025), most of which are reported by hunters as neither country is well surveyed.

The breeding grounds of these birds are a matter of speculation. Perhaps a small number of Little Bustards nest in Kandahar, where there has been little fieldwork, but where intriguing spring observations (March and April) indicate that birds might not

Plate 3. Little Bustards at Dashtobod, Jizzakh, Uzbekistan, a new wintering site in the Turkestan flyway (but note the powerlines), 12 January 2025. © *Kőrösi Levente*

Plate 4. Hunted Little Bustard in the South Asia flyway, with Common Quail *Coturnix coturnix*, Thana, Malakand, Khyber Pakhtunkhwa, Pakistan, 17 February 2021. Photographer anonymous. Contributed by Pakistan Historical Records/eBird.

only pass the winter there (Ostrowski 2025). Another plausible source for the birds wintering in Balochistan and Sindh is Iran, where small breeding populations in the Caspian lowlands, if still extant, are on the verge of complete extirpation (Ashoori *et al* 2025). A handful of breeding attempts have also been registered in the Kopet Dag range of Turkmenistan, the most recent in 2023 (Rustamov & Shcherbina 2025).

If the breeding grounds do not lie within South Asia itself, these wintering birds may represent the longest-distance migrant Little Bustards on the Turkestan flyway. To reach northern Pakistan, this would require either a circuitous journey involving a counter-clockwise orientation not observed in Little Bustards elsewhere in Asia, or flight from Tajikistan through the Hindu Kush via a pass such as Salang at almost 4000 m elevation. However, both of these options—a northbound leg or a high-altitude pass—would seem counterintuitive for birds presumably moving to avoid winter weather.

Outside Iran and Turkmenistan, where protected areas are monitored and some targeted surveys are undertaken, the presence of Little Bustards in this flyway is not well described. It would seem from available records that in this flyway the Little Bustard is on the brink of total extirpation, with the primary threat—and also primary source of records—being illegal hunting (Plate 4). We thus estimate that perhaps 10–50 breeding Little Bustards remain within this region.

CONCLUSIONS

Overall trends

By summing the population estimates made above for each of the flyways within the eastern range of the Little Bustard, we arrive at a total estimate of 94 700–178 320 breeding Little Bustards within the eastern population (Table 7). Our minimum estimate is 150% higher than that of Morales & Bretagnolle (2022a), and our maximum estimate is 25% higher. The differences between our results may be attributed as much to the finer-grained detail of this review as to actual changes in population size. Note additionally that the numbers we present for the eastern range refer to breeding individuals, whereas those for the western range are presented for 'individuals'. We find that the eastern population now accounts for almost two-thirds of a global estimated population of 145 894–288 279 Little Bustards (Table 7).

Table 7. The estimated total breeding numbers of Little Bustard within their eastern range, obtained by summing our estimates for each flyway. The percentage contribution of each flyway to the entire eastern population is estimated. The western range population estimate is from Morales & Bretagnolle (2022a).

	Estimated breeding individuals			
Flyway	**Minimum**	**Maximum**	**Percentage of eastern population**	**Overall trend**
Black Sea	100	120	0.1%	Declining
Caucasus	69 850	128 150	72–74%	Mixed
Turkestan	24 740	50 000	26–28%	Mixed
South Asia	10	50	<0.1%	Near extirpation
Totals			**Percentage of global population**	
Eastern range	94 700	178 320	62–65%	Mixed
Western range ('individuals')	51 194	109 959	35–38%	Declining
Global estimate	**145 894**	**288 279**		

It is clear that the eastern population of Little Bustards cannot be regarded as a single entity, as trends within its component flyways differ greatly. Little Bustards within the Black Sea and South Asia flyways are declining and near extirpation. Simultaneously, Little Bustards are expanding into foothill habitats in southern Kazakhstan (Shakula *et al* 2017) and have resumed breeding in Kyrgyzstan (Campeau *et al* 2022). The Caucasus flyway contains by far the largest numbers of Little Bustards, but the concentration of these birds during winter, when they are more easily counted, may disguise regional variation in trends across the breeding grounds from which they originate, where there may be very different agricultural practices.

We see a continuation of the 150-year trend towards an increasing gap between the western and eastern ranges, as Little Bustard populations in Crimea, mainland Ukraine and Türkiye, all considered Critically Endangered (Kılıç & Eken 2004, Andryushchenko 2009, Kostin 2015), continue to decline (Figure 1). Our review identifies a continuing diminishment in area of the eastern range, with contraction along three of its boundaries. First, the western edge, previously identified within Ukraine, now effectively lies east of the midpoint of the Pontic–Caspian steppe. Second, a trend towards wintering at higher latitudes has the effect of moving the southern boundary in Asia northwards. Third, to the east, the Little Bustard has been extirpated from Ningxia and southern Xinjiang (Gao *et al* 2008). Breeding birds are no longer observed in China, and autumn passage is constrained to the extreme west of Tacheng prefecture, Xinjiang, where regular flocks of 10–20 birds and occasionally over 100 birds are observed (Muyang Wang pers comm, xinjiang.china.birding.day, eBird).

We also observe a continued contraction of wintering populations into border areas (Yousefi *et al* 2017; Figure 1), coinciding with the higher hunting pressure reported in winter quarters.

Conservation measures

Having collated and considered the numbers of birds in each of the eastern range states of the Little Bustard, we reach the mildly encouraging conclusion that the species retains a moderately healthy population in the region of 94 700–178 320 adults, with declines in many areas being to some degree offset by increases in others. Nevertheless, five factors

render the outlook for the species discouraging, and need addressing: these are the persistence and ubiquity of hunting, agricultural (re)intensification, the proliferation of powerlines, the effects of global warming and inadequate investment in scientific research and management resources.

Hunting is by far the oldest and most widespread threat to the species. Among the 15 nationally dedicated papers in this *Sandgrouse* special feature, covering 18 countries, plus one covering the Arabian peninsula, hunting (also termed poaching depending on circumstance) is identified as the main threat in eight (Afghanistan, Armenia, Azerbaijan, Iran, Iraq, Lebanon, Tajikistan and Turkmenistan [at least until 2018]) plus the Arabian peninsula, and as a significant threat in seven (Georgia, Kazakhstan, Kyrgyzstan, Pakistan, Syria, Türkiye, Uzbekistan), with only three (Israel, Jordan [still officially to record the species] and Russia) not commenting. These countries have deep-rooted hunting traditions, but the threat that hunting poses also to Great Bustard (Endangered) and Asian Houbara *Chlamydotis macqueenii* (Vulnerable) in many of them is such that a major outreach campaign to press for stronger legal enforcement and greater self-regulation by hunters through their associations and clubs may be a way forward (Dolman *et al* 2021, Kessler & Batbayar 2023). Most particularly, however, the curtailing of poaching in Azerbaijan, where up to 30 000 Little Bustards may be killed each year (Brochet *et al* 2019) and where international falconry interest seems to be stirring (Collar & Kessler 2021, Farajli 2025), will be vital to the maintenance of the thousands of birds that funnel into the country to escape the winter in Russia and north-west Kazakhstan.

It is certain that agricultural intensification represents a major threat to the Little Bustard, as is obvious now from the trajectory of its populations in the Iberian peninsula (Morales & Bretagnolle 2022a) and Türkiye (Özgencil *et al* 2025). It may well come to surpass hunting as the primary cause of decline, although it is instructive to note that Little Bustard numbers in Kazakhstan in the middle of the 20th century plummeted not only through loss of habitat and the impact of mechanised harvesting on productivity and survival (see Campeau *et al* 2025) but also because 'new settlers mercilessly destroyed the fauna of the virgin steppes' (Mazhitova *et al* 2021). The abandonment of agriculture following the end of the Soviet Union led, in many areas, to the recovery of farmland and steppe bird populations, but, as the former Soviet countries recovered economically, agricultural re-intensification was thought likely to reverse these numerical gains (Kamp *et al* 2011). In terms of impacts on Little Bustards, the evidence varies geographically and temporally. In the Volga region the loss of both grazing and agriculture produced unsuitable breeding habitat; although a resumption of economic activity is promoting the reclamation of farmland, clutches are destroyed (Oparin *et al* 2025). Intensification threatens the recovery of breeding populations in Kyrgyzstan (Campeau *et al* 2025). On the wintering grounds, intensification has resulted in less suitable habitats in Tajikistan (Muratov 2025) but attractive ones in Turkmenistan (Rustamov & Shcherbina 2025). Given differences in breeding and crop phenology, research specific to localities throughout the range of the Little Bustard is needed to provide the evidence base for the development of environmentally sound policy and practice in food production.

The development of renewable energy in response to climate change, widely recognised as a global imperative, is advancing with great speed in many of the Little Bustard's range states, and typically involves vast installations at remote sites, with energy transmitted via long-distance powerlines—a flight hazard that bustards, in particular, cannot see (Silva *et al* 2023). The sunny, windy steppe landscapes inhabited by Little Bustards in their eastern range provide huge opportunities for solar and wind power capture and are now prime targets for energy developments on a massive scale, such as outlined above for the

Turkestan flyway. These structures will assuredly devastate Little Bustard populations, as they already do in Iberia (Marcelino *et al* 2017).

Climate change itself will require ongoing modification of crop choice and agricultural work schedules, with impacts on Little Bustards that are difficult to predict. However, higher temperatures inhibit activity in this species, constraining breeding and foraging schedules to the point where productivity and survival may be compromised (Silva *et al* 2015). A trend towards using more northerly wintering grounds, as noted above, has not yet been matched by a northward shift in breeding range. Paradoxically, if migratory distances between breeding and wintering areas diminish, there may be an incidental benefit owing to the reduction in the number and range of threats (including powerlines) the travelling birds face, even providing conservationists with opportunities to retain them on their breeding grounds, where stronger protections can be implemented (*eg* Bankovics & Lóránt 2018, Guo 2021). Nevertheless, reducing migratory or dispersive behaviour may render birds less able to escape further rising temperatures, and result in unforeseen impacts on metapopulation dynamics. Certainly, the dangers to the future of all biodiversity, including human life, will only multiply if politicians and citizens fail to take vigorous and immediate action to reduce carbon emissions.

To engage with and control hunting, develop and implement ecologically sustainable and wildlife-compatible food production, and campaign articulately for both decarbonisation and measures to reduce the impact of energy infrastructure on wildlife including the Little Bustard (via on-site generation or full mitigation of powerline impacts) requires major investment in integrated but independent systems of applied research and practical management. Telemetry studies would yield invaluable information on the distribution of Little Bustard populations in summer, on migration and in winter, as well as on survival rates, threats and management responses. Studies on productivity and survival related to habitat availability would point to land-use strategies that best combine the interests of farming and wildlife. Sensitive use of media—television, radio and social—could transform popular understanding of the dangers of uncontrolled hunting, unchecked carbon emissions and unmitigated powerlines, as well as generate interest and pride in steppe areas often perceived as empty 'wastelands' awaiting proper development. Such measures may seem fanciful when expressed so starkly, but they represent the best options for ensuring that the Little Bustard survives the great changes that are undoubtedly coming to the countries of its eastern range.

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Mimi Kessler, IUCN Bustard Specialist Group, Riyadh, Saudi Arabia. mimi@eurasianbustardalliance.org

Louis-Philippe Campeau, IUCN Bustard Specialist Group, Bishkek, Kyrgyzstan. louisphilippecampeau@gmail.com

NJ Collar, BirdLife International, Pembroke Street, Cambridge CB2 3QZ, UK