Preservation of major migratory populations of Asian Houbara *Chlamydotis macqueenii* requires undergrounding of Uzbekistan's Kungrad powerline

NIGEL J COLLAR & MIMI KESSLER

Summary: Uzbekistan's laudable pursuit of renewable energy requires new infrastructure such as the Kungrad Wind Farm, which will run an overhead transmission line (OHTL) from the far west for 800 km south-east to the vicinity of Bukhara. This presents a serious danger to migratory birds and particularly to 85% of the global population of the Asian Houbara *Chlamydotis macqueenii*, a bustard that breeds to the north of the line and migrates nocturnally to its south. This additional source of powerline-related mortality, known to be significant, represents a huge additional pressure on the Asian Houbara, already declining (and globally threatened) owing to over-hunting. Bird flight diverters (BFDs) fitted to OHTLs reduce collision rates in most bird taxa, but not sufficiently in bustards. The alternative of undergrounding (burial of lines) is typically rejected on the basis of expense, although this invariably takes no account of all the many costs over the operation's lifetime, or of intangible costs like loss of wildlife populations, wilderness and landscape value. Undergrounding of the Kungrad powerline is the only acceptably certain means of preserving the Asian Houbara's large breeding populations in Central Asia.

With a change in leadership in 2016, Uzbekistan initiated a new economic plan within the self-imposed constraints of a low-carbon energy strategy (Kawase 2021). An advisory report ('roadmap') summarising the actions needed to rapidly secure carbon neutrality in the nation's energy sector outlines a narrow 30-year window (2021–2050) to move electricity generation from fossil to renewable resources (Corporate Solutions Limited *et al* 2021). Given the ever-mounting evidence of cataclysmic climate change across the planet (Kemp *et al* 2022), such a measure is to be welcomed whole-heartedly.

Nevertheless, it has been apparent for decades that renewable energy infrastructure can result in multiple negative impacts on wildlife. Uzbekistan hosts significant populations of threatened avian species, notably birds of prey and bustards, which are at particular risk from collisions, electrocution and displacement from the renewable energy developments that are expanding across their extensive desert and semi-desert habitats. It is therefore encouraging that the 'roadmap' (Corporate Solutions Limited *et al* 2021) gives cardinal prominence to 'environmental protection', not only in respect of climate change mitigation and resilience but also concerning 'impacts of new projects on biodiversity and environmentally protected sensitive areas'.

It is somewhat less encouraging, however, that the IUCN Bustard Specialist Group has already found itself in damage-limitation negotiations with the developers of energy infrastructure with the potential for serious impacts on this group of large, mainly open-country, terrestrial birds. Several major wind and solar farms in Uzbekistan and their associated transmission lines, now under construction, will have a considerable effect on what are (a) both a major breeding area and an integral component of the global flyway for the (Vulnerable) Asian Houbara *Chlamydotis macqueenii* (as identified in, *eg*, Combreau & Al Baidhani 2015) and (b) overwintering areas and movements of the most important Central Asian population of the (Endangered) Great Bustard *Otis tarda* (Kashkarov *et al* 2022, Kessler 2022, Kessler & Batbayar 2023).

Most concerning for the future of these species, but particularly Asian Houbara (Plate 1), are plans for a renewable energy project of enormous geographical scope and financial scale. The Kungrad Wind Farm, involving 188–260 turbines, will be built near the far-

Plate 1. Male Asian Houbara *Chlamydotis macqueenii* preparing to display, Kyzylkum Desert, Uzbekistan, 6 April 2022. © *RJ Burnside*

Plate 2. Kyzylkum Desert, Uzbekistan, 17 April 2015. © *NJ Collar*

Plate 3. Four-egg clutch of Asian Houbara, Kyzylkum Desert, Uzbekistan, 16 April 2015. © *NJ Collar*

western border of Uzbekistan in the Autonomous Republic of Karakalpakstan, with the plan to deliver 1.5 GW to the big cities in the centre-east of the country through a large overhead transmission line (OHTL) that will run no less than 800 km to a substation south-west of Bukhara (ACWA Power and ECO Consult 2023).

The planned position of this line, cutting north-west to south-east across the southern part of the Kyzylkum Desert (Plates 2, 3), lies perpendicular to the direction of spring and autumn migration of the Asian Houbara (Figure 1). The great majority of the breeding population of this species survives in the 'cold' deserts and steppes of Central Asia east to the Mongolian Gobi, whence it migrates to winter amidst a smaller population of resident birds in the 'hot' deserts and plains of the Arabian Peninsula, Iraq, Iran, Afghanistan, Pakistan and India (Riou *et al* 2012, Collar *et al* 2017). Consultations a decade ago (Allinson 2014) yielded estimates of the numbers of Asian Houbaras breeding and wintering north and east of Kungrad's proposed OHTL, showing that perhaps 68 885–80 290 birds (some 85% of the estimated global total) will have to cross the proposed OHTL twice a year (Table 1). Superimposition of known flight paths of tracked Asian Houbaras (Combreau *et al* 2011) onto the map showing the OHTL's course (Figure 1) confirms this, as does a schematic map representing the migration routes of

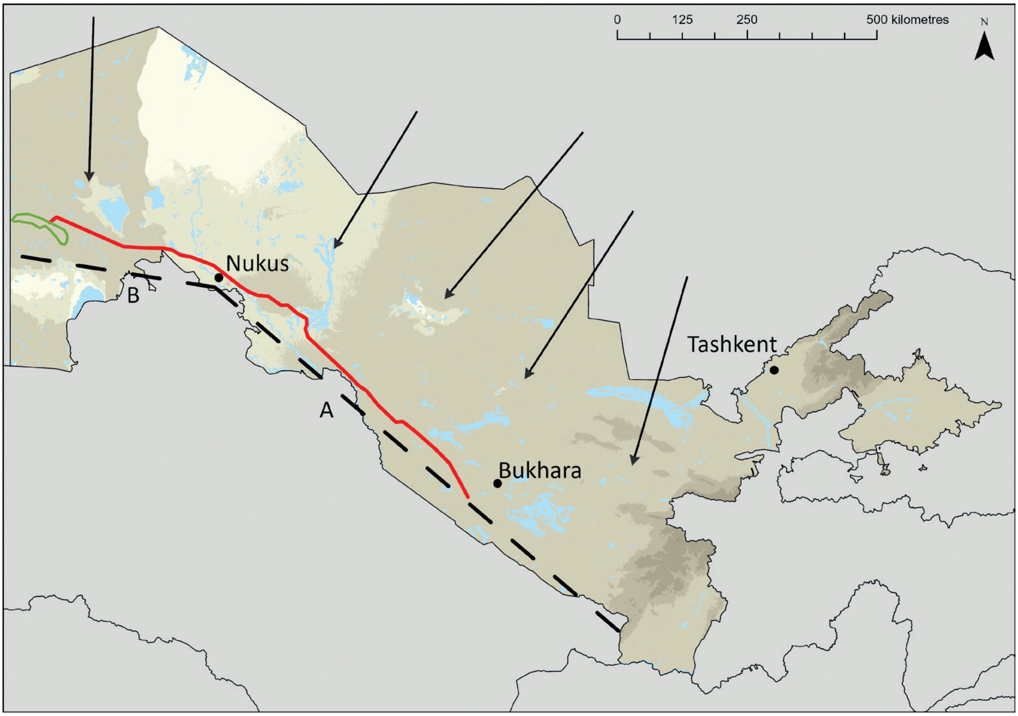

Figure 1. The course of the Kungrad Wind Farm overhead transmission line (OHTL) planned to run across Uzbekistan (red line, wind farm area outlined dark green). The broad front of the Asian Houbara migration flightpath from and to areas to the north-east and east, based on evidence in Combreau *et al* (2011), is shown as dashed black line A. The somewhat narrower migration front across which the species moves from and to areas immediately to the north, based on evidence in Launay *et al* (1999), Allinson (2014) and International Fund for Houbara Conservation (2020), is shown as dashed black line B. These flightpaths in combination (and essentially representing a single flyway) are used by some 85% of the estimated global population of the Asian Houbara (Table 1), with birds having to cross the proposed OHTL twice a year.

approximately 3000 tracked Asian Houbaras published by the International Fund for Houbara Conservation (2020: 34).

The classification of the Asian Houbara as IUCN Vulnerable is almost entirely due to uncontrolled range-wide hunting and poaching, which has produced a long-term decline in numbers in spite of (and arguably now even because of) the constant reinforcement of populations by captive-bred birds, which, if involving poor-quality mass-produced individuals, may 'impair rather than improve the viability of the free-living population' (Collar *et al* 2017, Dolman *et al* 2021a,b, Collar 2022). However, in the only published study undertaken of the effects of powerlines on Asian Houbaras, the population of the species in the Kyzylkum Desert in Uzbekistan was found to experience a 3% mortality rate as result of collisions with wires (Burnside *et al* 2015). In a species already declining in response to serious overhunting, the additional burden of such mortality cannot be sustainable, resulting in a slow but ineluctable extinction.

The standard solution to the problem of powerline fatalities is the installation of bird flight diverters (BFDs), relatively small devices with certain characteristics intended to make them more visible to birds than the wires to which they are attached. These make a difference for many species of birds, but they are never 100% effective (Ferrer *et al* 2020), and in the case of bustards the limited evidence remains so inconsistent (Silva *et al* 2023) that their deployment as an effective means of minimising impacts rests on nothing more than

Table 1. Numbers of Asian Houbaras estimated to breed and to winter in areas north and east of the proposed Kungrad Wind Farm OHTL with numbers consequently estimated to cross the OHTL twice a year, based on figures in Allinson (2014).

Region	Minimum	Maximum
Jungar Basin	6100	8140
Inner Asian Great Lakes Depression & Gobi Desert	4920	5740
Betpak-Dala	17 785	20 750
Balkash area	23 940	27 360
Kyzylkum Desert	16 800	19 200
Total Asian Houbara breeding north of proposed OHTL	69 545	81 190
Asian Houbaras wintering north of proposed OHTL	660	900
Number of Asian Houbara crossing proposed OHTL	68 885	80 290
Estimated total world population of Asian Houbara	79 000	96 600
% of world population crossing OHTL	87	83

an assumption. To compound the problem (or indeed partly to explain it), a small study of the closely related African Houbara *C. undulata* recently found that 70% of powerline collisions occurred at night (Alonso *et al* 2024). Asian Houbaras are nocturnal migrants, generally flying 'within 100 m of the ground' (Combreau & Al Baidhani 2014), so this new evidence indicates that, to address the majority of collisions involving houbaras, BFDs would need to be detectable to them at night and produce a strong avoidance response.

Once built, the Kungrad OHTL will constitute a decades-long day-and-night obstruction and danger to virtually every migratory bird on the huge flyway formed by the funneling effect of the Tien Shan and Alai mountain ranges to the east and the Aral and Caspian Seas to the west. There can be no certainty that, however many BFDs are fitted, the line will not steadily deplete numbers of the Asian Houbara until they become unviable, or that populations of other threatened migratory and/or locally breeding species (*eg* Sociable Lapwing *Vanellus gregarius*, Critically Endangered; White-headed Duck *Oxyura leucocephala*, Egyptian Vulture *Neophron percnopterus* and Steppe Eagle *Aquila nipalensis*, all Endangered) will not suffer significant and permanent damage; even the Little Bustard *Tetrax tetrax* (Near Threatened) will be at elevated risk based on knowledge of its movements into Turkmenistan (Saparmuradov 2011). The sheer length of the OHTL represents a threat to the integrity of the Central Asian avifauna that is as comprehensive and indiscriminate as trawling practices are to the biodiversity of the ocean floor.

The need for undergrounding

'Undergrounding'—or burial—of the Kungrad line is the only measure that can guarantee that no damage will be done by the project to the Central Asian populations of Asian Houbara, or to any other bird populations. We cite the example of EU LIFE projects in Austria and Hungary, where undergrounding powerlines has resulted in one of the few increasing Great Bustard populations in the world (Raab *et al* 2012). Regrettably, however, the almost invariable response to recommendations to bury powerlines is that the measure is too expensive. The claim is commonly made so emphatically as to appear non-negotiable, and has the (clearly desired) effect of abruptly terminating all further discussion. However, this approach is misguided, for a suite of reasons (Larsen 2016, Glass & Glass 2019):

- Inappropriate comparisons are sometimes used to support claims that the cost of undergrounding is too high, *eg* the per-kilometre cost of undergrounding a line in a metropolis may be used to estimate costs of undergrounding in remote pastureland (Glass & Glass 2019). Genuine local cost estimates are required for meaningful consideration of the option of undergrounding.
- Cost analysis in these cases typically compares the initial costs of powerline installation but not those of mitigation, maintenance and repairs over the life-span of the infrastructure (Fenrick & Getachew 2012, Larsen 2016). Overhead powerlines are vulnerable to severe weather events, the frequency of which is likely to increase with climate change (Trakas & Hatziargyriou 2022). Long-distance overhead transmission powerlines are also vulnerable to outages due to intentional sabotage.
- Costs of maintenance, repair and replacement of BFDs must be accounted for alongside costs of initial fitting (Dashnyam *et al* 2016). Additional offsets are required by funders to make up the shortfalls in BFD performance. Some of these measures, if undertaken properly and over the lifetime of the line, are likely to be very expensive.
- Cost analysis often does not consider the lost productivity and extra expenses incurred to customers during outages (Fenrick & Getachew 2012).
- Rates of human injury and loss of life related to overhead powerlines are high (Brenner and Cawley 2016).
- Cost-accounting does not take into consideration the cascading ecological effects of powerlines. Novel, anthropogenic vertical structures provide nest and perch sites for predator species that are naturally scarce in open landscapes. Artificially increased predator density negatively impacts survival and reproductive success of terrestrial species, including reptiles and ground-dwelling birds such as the African Houbara (Bacon 2017).
- The installation of vertical transmission towers and aerial lines in a naturally open environment fundamentally damages the aesthetic of the landscape, irreversibly diminishing the human experience of the natural environment. It is to be noted that the deserts of Central Asia form one of 24 globally important *intact* (our emphasis) wilderness areas (Mittermeier *et al* 2003), whose capacity to inspire thought and feeling depends on the integrity of its natural condition, offering among other things 'scenic value' and 'outstanding opportunities for solitude' (IUCN 1994). These are key elements in maintaining the overall quality of human life that should command the respect and allegiance of all authorities entrusted with the economic and social development of the planet.

The tangible benefits (no BFD or offset costs, low overall repair and maintenance costs, low economic and social damage, low risk to the public) combine with intangible ones (no bird deaths, no biodiversity loss, no spoilt landscapes, aesthetic and spiritual fulfilment at personal and community levels) to make a compelling case for burying powerlines (Table 2). Moreover, in the particular context of the Kungrad OHTL, it should be noted that sandstorms and extreme annual temperature oscillations in the Kyzylkum are likely to truncate the lifespan of any BFDs, as has happened in the Mongolian Gobi (Dashnyam *et al* 2016), requiring monitoring and replacement, and thus greatly magnifying the costs of the mitigation. Furthermore, Uzbekistan already has thousands of miles of buried oil and gas pipelines, indicating that the skills, technology and political will for undergrounding exist in the country.

The importance of burying the Kungrad line, not just to spare a species and an intact landscape but also to set a precedent, cannot be overstated. Doing so will not in itself

Table 2. An outline of major costs and benefits of overhead and underground powerlines as described in the scientific literature.

Overheading		**Undergrounding**	
Cost	*Benefit*	*Cost*	*Benefit*
	significantly cheaper at first	significantly costlier at first	
damage frequent so maintenance rate high	much cheaper repairs, but ←	much costlier repairs, but →	damage rare so maintenance rate low
high cost of BFDs† and their regular replacement			no cost or replacement of BFDs
vulnerable to outages* and associated costs			greater service reliability, lower outage costs
birds killed			no birds killed
permanent biodiversity loss from collision and electrocution; increased predator presence ⁑			surface vegetation damage greater than for overheading, but temporary
destroys aesthetic of landscape; preferences of residents ignored			preserves aesthetic of landscape; retains value for residents and tourists
higher public and employee health and safety risk			lower public and employee health and safety risk
requirement for additional offsets‡			no additional offsets

†Includes installation, maintenance, repair and regular replacement over the powerline's lifetime. *Consequent on weather conditions, treefalls, lightning strikes, high winds and natural fires, entailing both economic and social damage. ⁑Increases in corvid populations following man-made structures across open landscapes inflate predation rates of ground-nesting birds and vulnerable taxa like tortoises (Manzer & Hannon 2005). ‡Since particularly in the case of bustards BFDs have to date exhibited low statistically significant levels of effectiveness, other offset measures will be needed over the powerline's lifetime.

guarantee the future of the Asian Houbara, but it will constitute a decisive step towards doing so. Other power-generating schemes will inevitably spring up all over Uzbekistan and, if Kungrad's line is not buried, the new lines that come after will not be either. The cumulative impact of a network of powerlines strung across the great expanses of the Kyzylkum and other open lands in Uzbekistan can be predicted with confidence to be devastating to Central Asia's larger birds.

The world is at a tipping-point on the issue of power transmission: the global transition to renewable sources of energy will require a doubling by 2040 of the length of the planet's current 80 million kilometres of lines (Hevia-Koch *et al* 2023)—enough new cabling to stretch to the moon and back more than 200 times. In this context, the burial of powerlines must become routine rather than rare. In February 2024 Uzbekistan hosted the 14th Conference of Parties of the Convention on Migratory Species (CMS), under which all signatories are *obliged* (our emphasis) to 'prevent, remove, compensate for or minimize… the adverse effects of' obstacles to migration (Article III, point 4b; https://www.cms.int/en/convention-text; also point 2.4 of UNEP/CMS/Resolution 10.11 [Rev.COP13] 'Power lines and migratory birds'). The Kungrad project offers a major opportunity for Uzbekistan to fulfil this obligation, lead the world in renewable energy best practice, and transform the way in which wildlife and biodiversity conservation is managed in the face of the global energy crisis. Without question, the only option to truly minimise the environmental impact of the Kungrad line—and keep hope alive for the great majority of the Asian Houbara population—is undergrounding.

ACKNOWLEDGEMENTS

We are most grateful to Tris Allinson for discussions, Mark Balman for preparing the map that is Figure 1, and Robert John Burnside for the use of his photograph.

LITERATURE CITED

ACWA Power & ECO Consult. 2023. *Uzbekistan: Kungrad 1 Wind Power BESS Project. Environmental and Social Impact Assessment. Part 6.* https://www.adb.org/sites/default/files/project-documents/57342/57342-001-esia-en_4.pdf.

Allinson, T. 2014. *Review of the global conservation status of the Asian houbara bustard* Chlamydotis macqueenii*. Report to the Convention on Migratory Species Office – Abu Dhabi*. BirdLife International, Cambridge.

Alonso, JC, I Abril-Colón, A Ucero & C Palacín. 2024. Anthropogenic mortality threatens the survival of Canarian houbara bustards. *Scientific Reports* 14: 2056.

Bacon, L. 2017. *Etude des paramètres de reproduction et de la dynamique d'une population renforcée d'outardes Houbara nord-africaines (*Chlamydotis undulata undulata*) au Maroc*. Doctoral dissertation, Museum National d'Histoire Naturelle, Paris, France.

Brenner, BYB & JC Cawley. 2016. At-risk occupations in power line fatalities. *IEEE Industry Applications Magazine* (February 2016): 2–7.

Burnside, RJ, NJ Collar, MA Koshkin & PM Dolman. 2015. Avian powerline mortalities, including Asian Houbara *Chlamydotis macqueenii*, on the Central Asian flyway in Uzbekistan. *Sandgrouse* 37: 161-168.

Collar, NJ, HS Baral, N Batbayar, GS Bhardwaj, N Brahma, RJ Burnside, AU Choudhury, O Combreau, PM Dolman, PF Donald, S Dutta, D Gadhavi, K Gore, OA Goroshko, C Hong, GA Jathar, RRS Jha, YV Jhala, MA Koshkin, BP Lahkar, G Liu, SP Mahood, MB Morales, SS Narwade, T Natsagdorj, AA Nefedov, JP Silva, JJ Thakuri, M Wang, Y Zhang & AE Kessler. 2017. Averting the extinction of bustards in Asia. *Forktail* 33: 1-26.

Combreau, O & MS Al Baidhani. 2015. *A natural history of the Asian Houbara Bustard*. International Fund for Houbara Conservation, Abu Dhabi.

Corporate Solutions Limited, Guidehouse & Tractebel. 2021. *A carbon neutral energy sector in Uzbekistan: summary for policymakers*. https://minenergy.uz/en/news/view/1090.

Dashnyam, B, T Purevsuren, S Amarsaikhan, D Bataa, B Buuveibaatar & G Dutson. 2016. Malfunction rates of bird flight diverters on powerlines in the Mongolian Gobi. *Mongolian J Biol Sci* 14: 13-20.

Dolman, PM, NJ Collar & RJ Burnside. 2018. Captive breeding cannot sustain migratory Asian houbara *Chlamydotis macqueenii* without hunting controls. *Biol Conserv* 228: 357-366.

Dolman, PM, RJ Burnside, KM Scotland & NJ Collar. 2021a. Captive breeding and the conservation of the threatened houbara bustards. *Endangered Species Research* 46: 161-173.

Dolman, PM, KM Scotland, RJ Burnside & NJ Collar. 2021b. Sustainable hunting and the conservation of the threatened houbara bustards. *J Nature Conserv* 61: 126000.

Fenrick, SA & L Getachew. 2012. Cost and reliability comparisons of underground and overhead power lines. *Utilities Policy* 20: 31–37.

Ferrer, M, V Morandini, R Baumbusch, R Muriel, M De Lucas & C Calabuig. 2020. Efficacy of different types of 'bird flight diverter' in reducing bird mortality due to collision with transmission power lines. *Global Ecol Conserv* 23: e01130.

Glass, E & V Glass. 2019. Underground power lines can be the least cost option when study biases are corrected. *Electricity J* 32: 7–12.

Hevia-Koch, P, B Wanner & R Kuwahata. 2023. *Electricity grids and secure energy transitions: enhancing the foundations of resilient, sustainable and affordable power systems*. International Energy Agency. https://www.iea.org/reports/electricity-grids-and-secure-energy-transitions.

International Fund for Houbara Conservation. 2020. *Corporate annual report 2019–2020*. International Fund for Houbara Conservation, Abu Dhabi.

IUCN. 1994. *Guidelines for protected area management categories*. IUCN, Gland, Switzerland & Cambridge, UK.

Kashkarov, RD, YO Mitropolskaya & AG Ten. 2022. The historical and current status of the Great Bustard *Otis tarda tarda* in Uzbekistan, a key winter refuge. *Sandgrouse* 44: 26-34.

Kawase, K. 2021. https://asia.nikkei.com/Spotlight/Environment/Uzbekistan-joins-global-carbon-neutrality-race-to-2050.

Kemp, L, C Xu, J Depledge, KL Ebi, G Gibbins, TA Kohler, J Rockström, M Scheffer, HJ Schellnhuber, W Steffen & TM Lenton. 2022. Climate endgame: exploring catastrophic climate change scenarios. *Proc Nat Acad Sci* 119: e2108146119.

Kessler, M. 2022. Status of the Western Great Bustard *Otis tarda tarda* in Asia and its significance to an updated estimate of the global population of Great Bustards. *Sandgrouse* 44: 6–13.

Kessler, M & N Batbayar (eds). 2023. *Revised action plan for the Great Bustard in Asia*. UNEP/CMS/COP14/Doc.28.5.3/Annex. https://www.cms.int/en/document/actionplan-great-bustard-asia.

Larsen, PH. 2016. A method to estimate the costs and benefits of undergrounding electricity transmission and distribution lines. *Energy Economics* 60: 47–61.

Launay, F, O Combreau & M Al Bowardi. 1999. Annual migration of Houbara Bustard *Chlamydotis undulata macqueenii* from the United Arab Emirates. *Bird Conserv Internat* 9: 155-161.

Manzer, DL & SJ Hannon. 2005. Relating grouse nest success and corvid density to habitat: a multi-scale approach. *J Wildlife Mgmt* 69: 110–123.

Mittermeier, RA, CG Mittermeier, TM Brooks, JD Pilgrim, WR Konstant, DAB da Fonseca & C Kormos. 2003. Wilderness and biodiversity conservation. *Proc Nat Acad Sci* 100: 10309-10313.

Raab, R, C Schütz, P Spakovszky, E Julius & CH Schulze. 2012. Underground cabling and marking of power lines: conservation measures rapidly reduced mortality of West-Pannonian Great Bustards *Otis tarda*. *Bird Conserv Internat* 22: 299–306.

Riou, S, O Combreau, J Judas, M Lawrence, MS Al Baidani & C Pitra. 2012. Genetic differentiation among migrant and resident populations of the threatened Asian Houbara Bustard. *J Heredity* 103: 64-70.

Saparmuradov, D. 2011. Bezbeltek [Little Bustard]. In: Annabayramov, B (ed). *Türkmenistanyň Gyzyl Kitaby* [Turkmenistan Red Book]. Vol. 2. Ed. 3. Ylym, Ashgabat, pp 274-275.

Silva, JP, AT Marques, T Allinson, Y Andryushchenko, J Bernardino, S Dutta, M Kessler, R Martins, F Moreira, M Pretorius, A Scott, M Scott, JM Shaw & NJ Collar. 2023. The effects of powerlines on bustards: how best to mitigate, how best to monitor? *Bird Conserv Internat* 33 e30: 1–14.

Trakas, DN & ND Hatziargyriou. 2022. Strengthening transmission system resilience against extreme weather events by undergrounding selected lines. *IEEE Transactions on Power Systems* 37: 2808–2820.

N J Collar, Co-chair IUCN Bustard Specialist Group, 25 Springfield Road, Cambridge CB4 1AD, UK

M Kessler, Co-chair IUCN Bustard Specialist Group, 185 N Center Street, Suites C–E, Jackson, WY 83001, USA