**Supplementary Material**

Current status of Great Bustard *Otis tarda* in Turkey: population size, distribution, movements, and threats

İBRAHIM KAAN ÖZGENCIL, FERDI AKARSU, MEHMET MAHIR KARATAŞ, ARZU GÜRSOY-ERGEN, FULYA SAYGILI-YIĞIT, MUHARREM KARAKAYA and MELISA SOYLUER

**Contents**

Figure S1. Map showing the geographic coverage of our studies.

Table S1. Population size estimates for Great Bustards breeding in Turkey since 1979.

Appendix S1. National Red List Assessment.

Appendix S2. Threat assessment.

Table S2. Studies conducted on *Otis tarda* in Turkey and the threats they report

Figure S2.Distributions of the minimum and maximum population size estimates for the Great Bustard leks in Turkey.

Figure S2.Distributions of the minimum and maximum population size estimates for the Great Bustard leks in Turkey.

References

****

**Figure S1.** Map showing the geographic coverage of our studies. Grey-colored provinces are the ones, in which we have conducted our field surveys, and the stars show the locations of the largest leks in Turkey.

**Table S1.** Population size estimates for Great Bustards breeding in Turkey since 1979. *\*These two estimates were done using the same information sources, making them redundant.*

|  |  |  |
| --- | --- | --- |
| ***Year*** | ***Population Size Estimate (Individuals)*** | ***Source*** |
| 1979 | 200-1000 | Collar (1979) |
| 1980 | 200-1000 | Cramp (1980) |
|  1981 | 4000  | de Trucios (1990) |
| 1981 | 3000-4000 | Goriup and Parr (1985) |
| 1996 | 800-3000 | Kollar (1996) |
| 1996 | 145-4000 | Kasparek and Bilgin (1996) |
| 2004 | 764-1250 | Kılıç and Eken (2004) |
| 2004 | 703-1065 | Özbağdatlı et al. (2004) |
| 2008 | 764-1250 | Palacin and Alonso (2008) |
| 2009 | 400-600 | Karakaş and Akarsu (2009) |
| 2010 | 400-1000 | Alonso and Palacin (2010)\* |
| 1990-2008 | 400-1000 | Alonso (2015)\* |
| 2016 |  700-1180 | Birdlife International (2018) |
| 2021 |  559-780 | Current Study |
|  |  |  |

We used all the available literature and online databases to make our final population estimates and range estimates. These sources were OST (1969, 1972, 1975, 1978), Goriup and Parr (1985), Beaman (1986), Kasparek (1987, 1989), Ertan *et al.* (1989), Eames (1991), Kirwan (1994, 2003), Kirwan and Martins (1994, 2000), Kirwan *et al.* (2010), Magnin and Yarar (1997), Heunks *et al.* (2001), Gürkan *et al.* (2003), Kılıç and Eken (2004), Kılıç and Karakaş (2005), Eken *et al.* (2006), Özbağdatlı and Tavares (2006), Karakaş and Akarsu (2009), Karataş (2012), Karataş and Özelmas (2013), Tanrıverdi (2015), Akarsu (2016), Usta *et al.* (2016), Özgencil and Özcan (2018), eBird (2019), Karataş (2020).

**Appendix S1. National Red List Assessment**

We used two different approaches to compensate for the lack of population estimates from exactly one, two, or three generations ago (Table S1), which are required to assess some of the criteria in the IUCN guidelines. First, we used the temporally closest population size estimates to make the evaluations; to be able to do this, we chose estimates that are more recent than the year that we needed the estimate. This approach ensures the validity of the trigger because if a particular trigger over a time period that is shorter than the time period mentioned in the criteria is obtained, it is likely to mean that the trigger is valid. Second, we used two temporally closest estimates, one being older and another being more recent than the actual time for which we need the estimate, and then we applied a linear extrapolation to obtain the estimate for the year of interest.

To check the criteria that concern population changes over three-generations-time (nearly 30 years for Great Bustards) by using the first approach, we used the population size estimate from 1996 (Kollar 1996), and we found that Great Bustard populations in Turkey have suffered a 30-74% (mean: 52%) decline over 24 years, which is 20% shorter than three-generations-time. Using the linearly extrapolated population size estimate for the year 1991, we found that the Great Bustard population in Turkey has declined by 64-77% (mean: 70.5%) over three generations.

By using the closest estimate (Özbağdatlı et al. 2004) to assess the criteria concerning changes over two-generations-time (nearly 20 years for Great Bustards), we found that the species has declined by 20-27% (mean: 23.5%) over a period of time 15% shorter than two generations. To obtain an estimate for 2001 (nearly two generations ago) by using linear extrapolation approach, we used population size estimates from 1996 and 2004 (Kollar 1996, Özbağdatlı et al. 2004), and we found that the populations of the species have declined by 28-59% (mean: 43.5%) over two generations.

In the end, we opted to rely on the 20-years decline estimates because the population size estimates we used for the 30-years decline give very large ranges (+-2,200 individuals; Table S1), making them less reliable. Since both 20-years and 30-years resulted in the same EN categorisation, this did not change resulted while allowing us to be conservative with our assessment.

**Appendix S2. Threat Assessment**

**Table S2:** <https://figshare.com/s/4d1fe512b27bdee6e605>

**Table S2**. Studies conducted on *Otis tarda* in Turkey and the threats they report

We used all the available sources that reported threats for *Otis tarda* in Turkey (1985-2020). The threats mentioned in the sources were given a score of 1, and the unmentioned threats were given a score of 0. Our percentage calculations included 22 different sources that specified a total of 13 threats.



**Figure S2.** Distributions of the minimum and maximum population size estimates for the Great Bustard leks in Turkey. The critical level 30 (Pinto *et al*. 2005) is indicated by arrow heads on the horizontal axis.

**REFERENCES**

Akarsu, F. (2016) *The Great Bustard (Otis tarda) 2016 Breeding Season in Central Anatolia, Turkey*, Doğa Derneği, Ankara, Turkey.

Alonso López, J. C. and Palacín, C. (2010) The world status and population trends of the great bustard (Otis tarda): 2010 update. *Chinese Birds* 141–147.

Alonso, J. C. (2015) The Great Bustard: Past, Present and Future of a Globally Threatened Species. *Ornis Hungarica* 22: 1–13.

Avcı, F., Adızel, Ö. and Azizoğlu, E. (2017) A Study On Ornithofauna of Muş Plain. *Journal of ADYÜTAYAM* 5: 20–32.

Beaman, M. (1986) Turkey Bird Report 1976-1981. *Sandgrouse* 8: 1–41.

BirdLife International (2018) Species factsheet: *Otis tarda*. Available at: http://www.birdlife.org [accessed 06 April 2018].

Collar, N. J. (1979) *Bustard Group general report*, ICBP Bull.

Cramp, S. (1980) *Handbook of the birds of Europe, the Middle East, and North Africa: the birds of the western Palearctic*. *Vol.* II. Oxford University Press.

de Trucios, S. J. H. (1990) World status of the Great Bustard (Otis tarda) with special attention to the Iberian peninsula populations. *Miscel· lània Zoològica* 14: 167–180.

Eames, J. (1991) More selected bird observations from Turkey: spring and summer 1990. *Bulletin of the Ornithological Society of the Middle East* 27: 29–31.

eBird (2019) *Basic Dataset. Version:*  *ebd\_TR\_relAug-2020*. Ithaca, New York: Cornell Lab of Ornithology. [accessed 8 March 2020].

Eken, G., İsfandiyaroğlu, S. and Bozdoğan, M. (2006) Türkiye’nin Önemli Doğa Alanları, Doğa Derneği, Ankara, Turkey.

Ertan, A., Kılıç, A. and Kasparek, M. (1989) *Türkiye’nin Önemli Kuş Alanları*, Doğal Hayatı Koruma Derneği, Istanbul, Turkey.

Goriup, P. D. and Parr, D. F. (1985) Results of the ICBP bustard survey of Turkey, 1981. *Bustard Studies* 2: 77–97.

Gürkan, Z., Bekir, S. and Özbağdatlı, N. (2003) *Great Bustard Conservation Project: East Anatolia Survey Report*, Doğal Hayatı Koruma Derneği, İstanbul.

Gürsoy Ergen, A. and Saygılı Yiğit, F. (2018) Monitoring of Great Bustard (Otis tarda) in Ankara Province period of 2016-2017.

Heunks, C., Heunks, E., Eken, G. and Kurt, B. (2001) Distribution and current status of Great Bustard Otis tarda in the Konya Basin, central Turkey. *Sandgrouse* 23: 106–111.

IUCN (2012) *Guidelines for Application of IUCN Red List Criteria at Regional and National Levels: Version 4.0*, IUCN, Gland, Switzerland and Cambrigde, UK.

Karakaş, R. and Akarsu, F. (2009) Recent status and distribution of the Great Bustard, Otis tarda, in Turkey: (Aves: Otidae). *Zoology in the Middle East* 48: 25–34.

Karakaya, M., Karataş, M. M. and Özelmas, Ü. (2017) Agricultural Pesticides Used in Eskişehir and Kütahya Population Areas of Great Bustard (Otis tarda, Linnaeus, 1758). *Commagene Journal of Biology* 1: 25–30.

Karataş, M. M. (2012) A study on the population of great bustard (Otis tarda, Linnaeus, 1758) in Altıntaş plain/Kütahya, Doctoral Dissertion, Eskişehir Osmangazi Üniversitesi, Eskişehir, Turkey.

Karataş, M. M. (2019) *Denizli, Kütahya ve Eskişehir İllerinde Toy Popülasyonlarının İzlenmesi*, Eskişehir Osmangazi Üniversitesi, Eskişehir, Turkey.

Karataş, M. M. (2020) Behavior and Population Characteristics of Great Bustard (*Otis tarda*, Linnaeus 1758) Living in Eskişehir, Kütahya and Afyonkarahisar Province, Doctoral Dissertion, Eskişehir Osmangazi Üniversitesi, Eskişehir, Turkey.

Karataş, M. M. and Özelmas, Ü. (2013) Kütahya/Altıntaş ovasındaki Büyük Toy Kuşu Otis tarda ’nun populasyonu üzerine bir çalışma. *Biyolojik Çeşitlilik ve Koruma* 6: 92–96.

Kasparek, M. (1987) *The Birds of Lake Kulu*, Max Kasperek Verlag, Heidelberg, Germany.

Kasparek, M. (1989) Status and distribution of the Great Bustard and Little Bustard in Turkey. *Bustard Studies* 4: 80–113.

Kasparek, M. and Bi̇lgi̇n, C. (1996) Türkiye Kuşları Tür Listesi. *Tübitak* 27–87.

Kılıç, A. and Karakaş, R. (2005) Recent observations on the Great Bustard, *Otis tarda*, in south-eastern Anatolia. *Zoology in the Middle East* 35: 99–102.

Kılıç, D. and Eken, G. (2004) *Türkiye’nin Önemli Kuş Alanları, 2004 Güncellemesi [Important Bird Areas of Turkey, 2004 update]*, Doğa Derneği, Ankara, Turkey.

Kirwan, G. (1994) The breeding status and distribution of the White-headed Duck Oxyura leucocephala on the Central Plateau, Turkey. *Sandgrouse* 16: 66–75.

Kirwan, G. M. (2003) Turkey Bird Report 1997-2001. *Sandgrouse* 25: 8–31.

Kirwan, G. M., Demirci, B., Welch, H., Boyla, K., Özen, M., Castell, P. and Marlow, T. (2010) *The Birds of Turkey*, Bloomsbury Publishing, London, UK.

Kirwan, G., and Martins, R. (1994) Turkey Bird Report 1987-91. *Sandgrouse* 16: 76–117.

Kirwan, G., and Martins, R. (2000) Turkey Bird Report 1992-1996. *Sandgrouse* 22: 13–35.

Kollar, H. P. (1996) Action plan for the Great Bustard (Otis tarda) in Europe. *Globally threatened birds in Europe. Council of Europe, Strasbourg* 245–260.

Magnin, G. and Yarar, M. (1997) *Türkiye’nin Önemli Kuş Alanları*, Doğal Hayatı Koruma Derneği, Istanbul, Turkey.

OST, Ornithological Society of Turkey. (1969) *Bird Report 1966-67*, Ankara, Turkey.

OST, Ornithological Society of Turkey. (1972) *Bird Report 1968-69*, Ankara, Turkey.

OST, Ornithological Society of Turkey. (1975) *Bird Report 1970-73*, Ankara, Turkey.

OST, Ornithological Society of Turkey. (1978) *Bird Report 1974-75*, Ankara, Turkey.

Özbağdatlı, N. and Tavares, J. P. (2006) *The Situation of Great and Little Bustards in Turkey*, Doğa Derneği, Ankara, Turkey.

Özbağdatlı, N., Karauz, S. and Bünyamin, A. (2004) *Toy Ulusal Eylem Planı*, Doğa Derneği ve Doğa Koruma ve Milli Parklar Genel Müdürlüğü, Yenişehir, Ankara.

Özgencil, İ. K. and Özcan, C. (2018) *Tuz Gölü Özel Çevre Koruma Alanı’ndaki Toy (Otis tarda) ve Bozkır Kartalı (Aquila nipalensis) Popülasyonlarının Araştırılması*, Doğa Derneği; T.C. Çevre ve Şehircilik Bakanlığı, Özel Çevre Koruma Kurumu Başkanlığı, Ankara, Turkey.

Palacín, C. and Alonso, J. C. (2008) An updated estimate of the world status and population trends of the great bustard Otis tarda. *Ardeola* 55: 13–25.

Pinto, M., Rocha, P. and Moreira, F. (2005) Long-term trends in Great Bustard (*Otis tarda*) populations in Portugal suggest concentration in single high quality area. *Biological Conservation* 124: 415-423.

Tanrıverdi, A. (2015) Research on the Reproduction Ecology of Great Bustard (*Otis tarda <i/> L., 1758) within the Border of Muş Province*, Doctoral Dissertion, Yüzüncü Yıl Üniversitesi, Van, Turkey.

Usta, T., Tatar, B., Yıldırım, G., Çatal, H. and Bolat, Ü. (2016) *Toy (*Otis tarda*) Tür Eylem Planı*, T.C. Orman ve Su İşleri Bakanlığı, Doğa Koruma ve Milli Parklar Genel Müdürlüğü, Yenimahalle, Ankara.