



First Data on Bird Electrocution in Jordan, with Comments on the Undertaken Conservation Efforts

Tareq Qaneer¹ & Dimitar Demerdzhiev^{2,3}

¹ The Royal Society for the Conservation of Nature, 4 Baker Al Baw Street, Amman, Jordan; E-mail: tareq.qaneer@rscn.org.jo

² Bulgarian Society for the Protection of Birds/BirdLife Bulgaria, 5 Leonardo da Vinci Street, 4000 Plovdiv, Bulgaria; E-mail: dimitar.demerdzhev@bspb.org

³ National Museum of Natural History, Bulgarian Academy of Sciences, 1000 Sofia, Bulgaria

Abstract: Avian electrocution has been well documented mostly in North America and Europe. In Asia, mortality due to hazardous power grid was studied mainly in Russia, Kazakhstan and Mongolia. However, this type of research is still rare in the Middle East region and the problem there remains poorly understood. Jordan is on the flyway of many threatened species, such as Steppe Eagle *Aquila nipalensis* (Hodgson, 1833), Egyptian Vulture *Neophron percnopterus* (Linnaeus, 1758) and Eastern Imperial Eagle *Aquila heliaca* (Savigny, 1809). Therefore, the study of the electrocution risk in the country is of crucial importance to clarifying the dangerous power lines, threatening birds and their subsequent mitigation. In this pilot study, we focused on regions comprising part of the eastern Mediterranean migration route of the Egyptian Vulture used also by other raptor species. We found 215 electrocuted birds belonging to nine species, as the most common victim was the White Stork *Ciconia ciconia* (Linnaeus, 1758) ($n = 197$). Raptors were the next most commonly electrocuted guild in our study, including globally endangered Steppe Eagle ($n = 2$) and Egyptian Vulture ($n = 1$). Most electrocution incidents were recorded on tower station ($KR = 2.43$). The power poles of Type 3 ($KR = 1$) and Type 6 ($KR = 0.75$) also caused high bird mortality. However, 742 poles of different types were insulated within the project „Urgent Actions to Strengthen the Balkan Population of the Egyptian Vulture and Secure Its Flyway” (LIFE16 NAT/BG/000874). We recommend the intensification of such research in order to evaluate how serious the problem really is in the Middle East region, identifying hotspots of electrocution mortality and implementing subsequent mitigation measures.

Key words: power grid, non-natural mortality, raptors, hazardous infrastructure, Middle East

Introduction

The development of the electricity transmission infrastructure is expected to expand globally in the next decades (GRIGGS et al. 2013). This will have highly negative impact on environment in different aspects such as habitat fragmentation due to power line corridors (ANDREWS 1990), the effects of electromagnetic fields (FERNIE & REYNOLDS 2005, BALMORI 2015), changes in species interactions (LAMMERS & COLLOPY 2007) and an increase in wildfires (GUIL et al. 2018). The most severe impact is the increase in

non-natural mortality due to electrocution on power pylons (LEHMAN et al. 2007, GUIL & PÉREZ-GARCÍA 2022) and collision with overhead wires (BERNARDINO et al. 2018). However, the electricity network can also present suitable nesting habitats and provide perching sites for many birds, including endangered species (MAÑOSA 2001, KARYAKIN 2008, TRAJANOWSKI et al. 2014, MAINWARING 2015).

Electrocutions concern different guilds of birds, but the most affected groups are raptors, corvids and storks (GUYONNE et al. 2001, DEMERDZHIEV et al. 2009, DEMERDZHIEV 2014). This threat is especially

harmful to the populations of some globally threatened species such as Steppe Eagle, Eastern Imperial Eagle, Spanish Imperial Eagle *Aquila adalberti* (Brehm, 1861) and Egyptian Vulture (KARYAKIN & NOVIKOVA 2006, GONZÁLEZ et al. 2007, LÓPEZ-LÓPEZ et al. 2011, ANGELOV et al. 2013, KARYAKIN 2013, LAZAROVA et al. 2020, OPPEL et al. 2021a, 2022, SHOBRAK et al. 2020, 2022, DWYER et al. 2023). Although research on bird mortality caused by hazardous power grids in Asia has increased over the past decade (DIXON et al. 2013, GUIL & PÉREZ-GARCÍA 2022, DWYER et al. 2023), this type of study is still rare in the Middle East region and the problem there remains poorly understood (KOLNEGARI et al. 2021, SHOBRAK et al. 2022). Since Jordan is on the flyway of many migrant species, including large raptors such as Steppe Eagle, Eastern Imperial Eagle, Lesser Spotted Eagle *Clanga pomarina* (Brehm, 1831) and Egyptian Vulture (BUECHLEY et al. 2018, OPPEL et al. 2021b, PANUCCIO et al. 2021), bird mortality due to the risky power grid is expected to be high. Therefore, the study of the electrocution risk in the country is of crucial importance to clarifying the hazardous power lines threatening birds and their subsequent mitigation.

In this pilot study focused on an area comprising part of the eastern Mediterranean migration flyway of the Egyptian Vulture (BUECHLEY et al. 2018, OPPEL et al. 2021a, b), we identified hazardous power lines causing mortality among birds of prey and took action to secure them. We present the results of power line surveys conducted along predetermined power lines across the country during the migration seasons of 2019 (spring and autumn) and autumn of 2021. This is the first study of this kind in the country, enlightening the problem of bird electrocution in the region and mitigation measures undertaken. They are also pilot in the region to solve this threat.

Materials and Methods

Study design

The study was carried out in three periods: spring 2019 (from 18 to 24 April), autumn 2019 (from 14 to 21 October) and autumn 2021 (from 17 to 21), covering powerlines of a total length of about 161 km. We focused the study in the southern and northern parts of the country around Ma'an, and Al-Mafraq, since the regions had been identified as areas of potentially high risk of electrocution incidents (Fig. 1). Since Ma'an Governorate is the largest governorate in the country, covering about 32,000 km², which is more than one third of the country's land area, a sample of power lines in the region was selected.

Sampling was based on records of power outages in the province, possibly due to bird collision. The survey was also extended to cover sections of power lines along the highway between Ma'an and Aqaba. In addition, parts of Aqaba Province in the western part of the country were also surveyed. A total of 161 km of power lines were inspected in the study area and 1998 poles of different types were checked (Fig. 1).

Several types of power poles, defined based on various combinations of the support structure (pole) and the number of insulators located on them, could be found in the studied areas. The main types of poles (20 Kv) included (Fig. 2):

Type 1: concrete pole with upright porcelain insulators located parallel to each other;

Type 2: concrete strain pole with powerlines below the crossarm; conductors run in parallel;

Type 3: wooden strain pole with one conductor above the crossarm;

Type 4: tower station;

Type 5: concrete pole with upright rubber insulators located parallel to each other;

Type 6: concrete strain pole with powerlines below the crossarm; conductors are suspended at different levels.

One-off walking inspections were carried out along the power lines. The inspections were performed by the transect method, counting the remains of victims within an area of 20 m on either side of each power supply line (DEMERDZHIEV et al. 2009, DEMERDZHIEV 2014). The following specifics of each power pole were considered: GPS coordinates, type of pole, habitats within a radius of 50 m around the pole. On finding a victim, the following data were entered in a standard field form: name of the line, individual pole coordinates, species, age, gender of the bird (when determined), the number of the victims, condition of the victims (fresh carcass, mummified carcass, feathers and bones, only feathers or only bones bearing traces of singes or burns), distance and position of the victim to the pole and wires, type of habitat. All victims within a radius of 5 m around the pole were considered electrocuted, while birds found under the wires were considered victims of collision (DEMERDZHIEV et al. 2009, DEMERDZHIEV 2014).

The calculation of the number of electrocuted birds was performed by introducing a Killing Rate index (KR) calculated by dividing the number of all victims of a certain type of power pole by the total number of power poles of the relevant type (DEMERDZHIEV 2014). The value obtained (KR) is per pole and varies ≥ 0 and the higher it is, the higher the

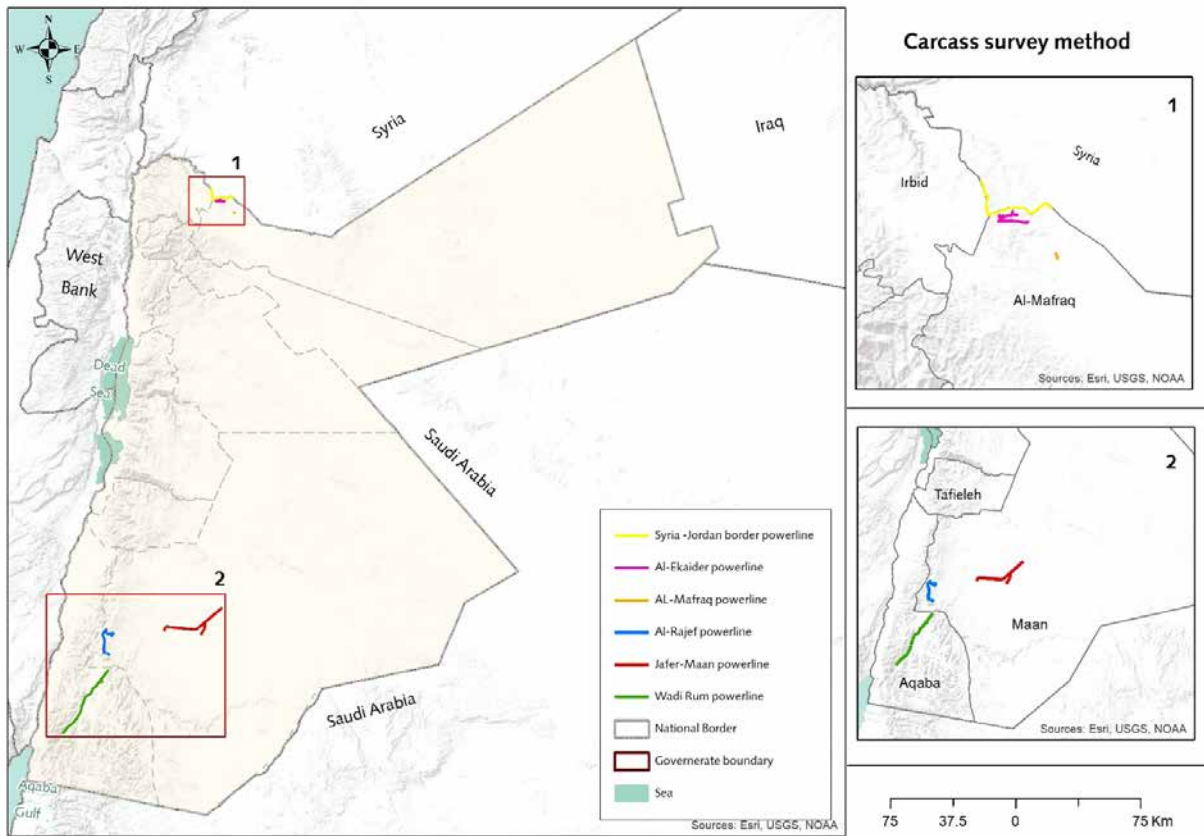


Fig. 1. Powerline route-transects covered during the survey

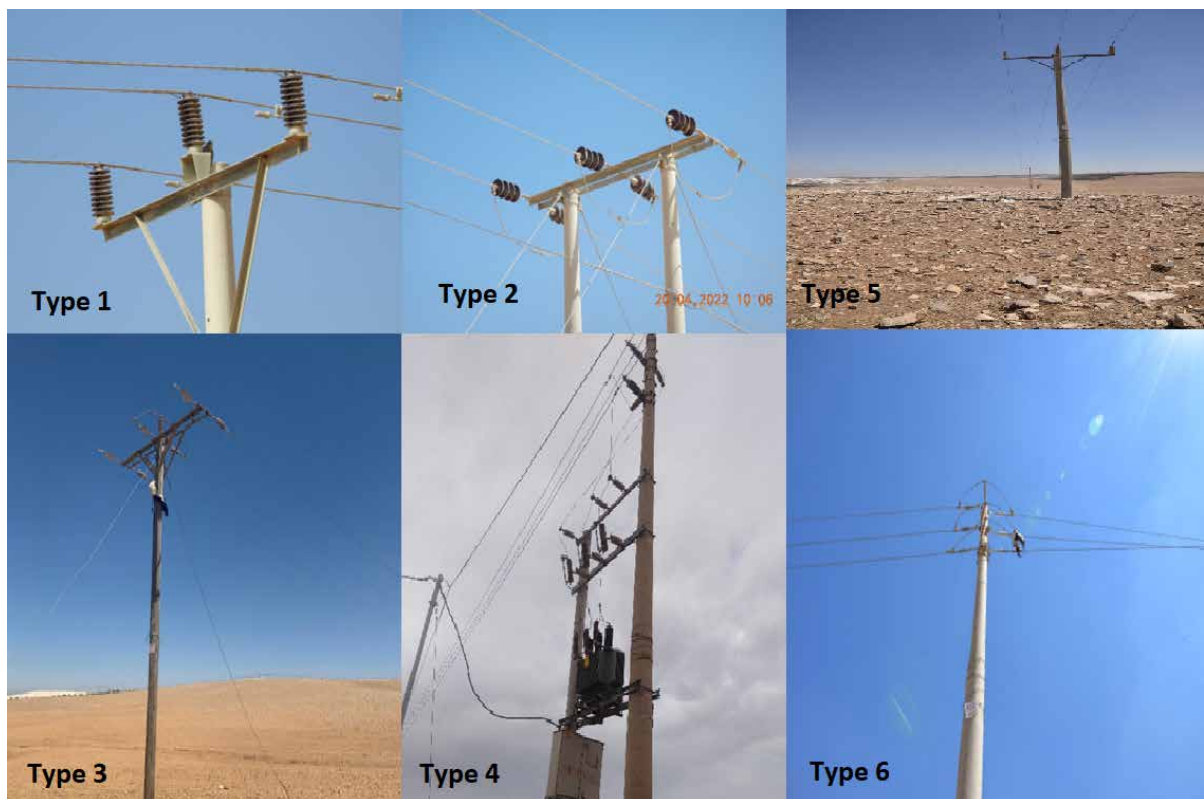


Fig. 2. Different 20 kV pole configurations surveyed in the study

danger of this type of pole is for the birds. This value was mostly used to guide us in identifying which power lines needed to be isolated urgently. To assess the importance of individual power lines for bird mortality, we calculated relative line mortality by dividing the number of victims found by the number of kilometres inspected of the given power line.

Results

Species mortality

We found 215 electrocuted birds from to nine species and the most common victim was the White Stork (n = 197) (Table 1). Raptors were the next most commonly electrocuted guild including large eagles such as Steppe Eagle (n = 2), Golden Eagle (*Aquila chrysaetos*) (n = 1), and medium sized Short-toed Eagle (*Circaetus gallicus*) (n = 6), Black Kite (*Milvus migrans*) (n = 3), Egyptian Vulture (n = 1) and Peregrine Falcon (*Falco peregrinus*) (n = 1). In general, birds of prey accounted for 6.51% of victims found. However, three Brown-necked Ravens (*Corvus ruficollis*) and a Little Egret (*Egretta garzetta*) were also detected and identified as electrocuted.

Pole design and habitat effect on electrocution rate

Most electrocutions were recorded on tower station (pole type 4) with KR = 2.43. The power poles of Type 3 (KR = 1) and Type 6 (KR = 0.75) also caused high bird mortality. However, poles of Type 5 and Type 1 less often caused electrocution in our study (Table 2). Most of the electrocution incidents were recorded in arable land, 98.1% (n = 211), while four birds (1.9%) were found in desert habitat.

Significance of power lines and conservation priority

Of all electrocuted birds found during the study, the Egyptian Vulture and the Steppe Eagle are categorized as globally endangered (Table 1). The most dangerous line was Al Mafraq, where 8.47 victims per km were found (Fig. 1, 3), followed by the lines Al Ekaider (6.54 victims/km), Syria-Jordan Border (4.65 victims/km), Al Jafer (0.24 victims/km), and Wadi Rum (0.10 victims/km). A total of 742 poles of different types were insulated within the project "Urgent Actions to Strengthen the Balkan Population of the Egyptian Vulture and Secure Its Flyway" (LIFE16 NAT/BG/000874) (Table 2).

Table 1. List of species died from electrocution and their global conservation status

| N | Species | Number of victims | % of victims | IUCN Red List Status |
|-------|---|-------------------|--------------|----------------------|
| 1 | White Stork <i>Ciconia ciconia</i> (Linnaeus, 1758) | 197 | 91.63 | LC |
| 2 | Little Egret <i>Egretta garzetta</i> (Linnaeus, 1766) | 1 | 0.47 | LC |
| 3 | Black Kite <i>Milvus migrans</i> Boddaert, 1783 | 3 | 1.4 | LC |
| 4 | Egyptian Vulture <i>Neophron percnopterus</i> (Linnaeus, 1758) | 1 | 0.47 | EN |
| 5 | Short-toed Snake Eagle <i>Circaetus gallicus</i> (Gmelin, 1788) | 6 | 2.79 | LC |
| 6 | Peregrine Falcon <i>Falco peregrinus</i> Tunstall, 1771 | 1 | 0.47 | LC |
| 7 | Steppe Eagle <i>Aquila nipalensis</i> Hodgson, 1833 | 2 | 0.93 | EN |
| 8 | Golden Eagle <i>Aquila chrysaetos</i> (Linnaeus, 1758) | 1 | 0.47 | LC |
| 9 | Brown-necked Raven <i>Corvus ruficollis</i> Lesson, 1831 | 3 | 1.4 | LC |
| Total | | 215 | 100 | |

Table 2. Killing rate established with the various types of power poles and number of insulated poles.

| Pole type | Number of poles | Number of victims | KR | Number of insulated poles | % of insulated poles |
|--------------|-----------------|-------------------|-------------|---------------------------|----------------------|
| Type 1 | 1251 | 15 | 0.012 | 220 | 17.59 |
| Type 2 | 124 | 0 | 0 | 30 | 24.19 |
| Type 3 | 65 | 65 | 1 | 45 | 69.23 |
| Type 4 | 7 | 17 | 2.43 | 7 | 100 |
| Type 5 | 511 | 88 | 0.17 | 415 | 81.21 |
| Type 6 | 40 | 30 | 0.75 | 25 | 62.5 |
| Total | 1998 | 215 | 0.11 | 742 | 37.14 |

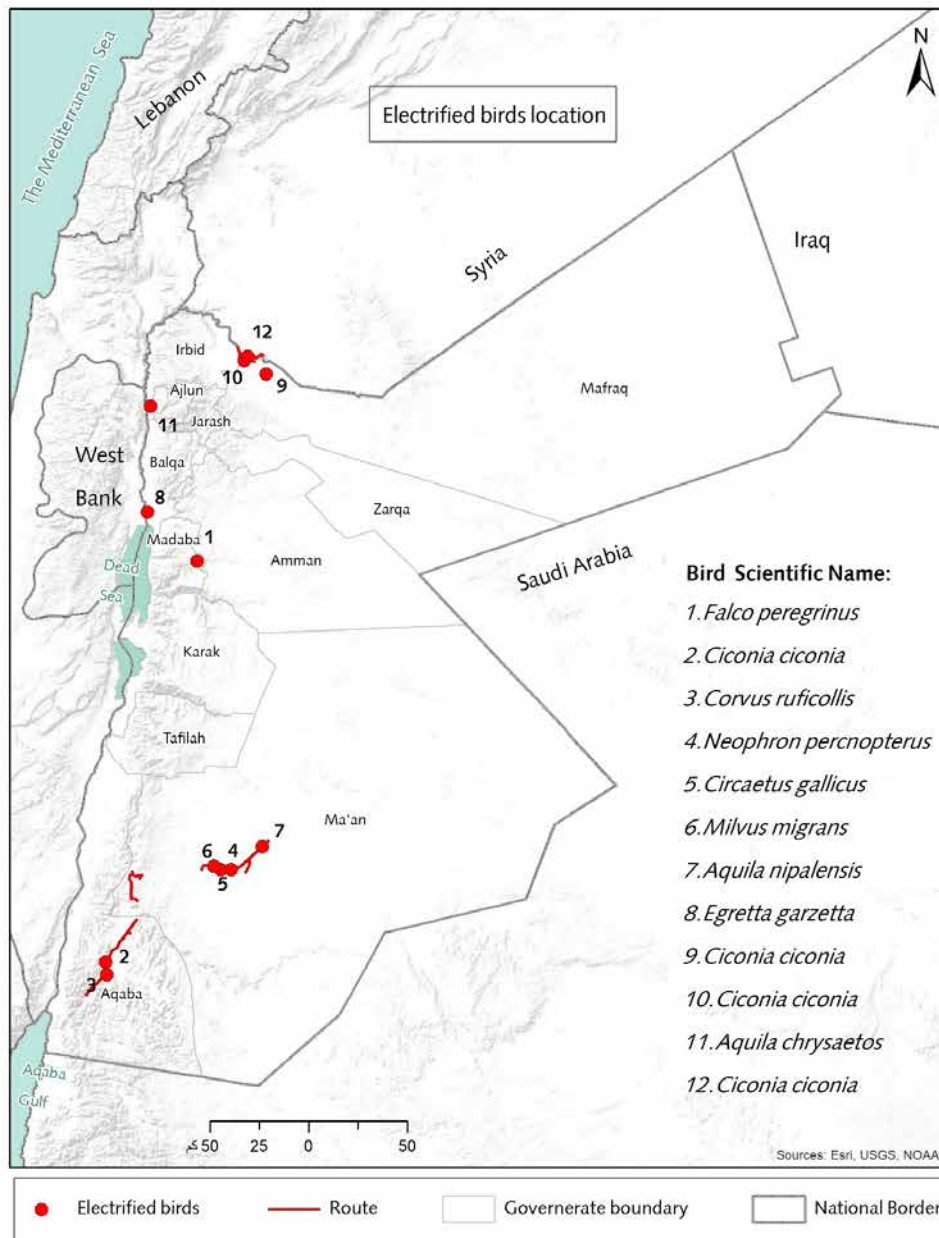


Fig. 3. Map of found electrocuted birds belonging to different species

Discussion

Our results confirmed previous findings, namely that White Stork and raptor guild are among the birds most affected by electrocution (DEMERDZHEV 2014, DWYER et al. 2023). Due to their large body size and their behaviour, preferring elevated perches, storks and diurnal raptors are particularly prone to electrocution.

Electrocution on poorly designed power poles is known as causing persistent mortality especially for species such as Egyptian Vulture and Steppe Eagle (KARYAKIN & NOVIKOVA 2006, ANGELOV et al. 2013, KARYAKIN 2013, KOLNEGARI et al. 2021, DWYER et al. 2023). However, persistent non-natural

mortality caused by electrocution in the whole distribution area is the main reason for severe population declines of Steppe Eagle (KARYAKIN 2013). Our results confirmed that tower station was extremely dangerous in terms of bird electrocution (DEMERDZHEV et al. 2009, DEMERDZHEV 2014). However, the high mortality reported for this pole type should be considered with caution due to the small sample size of tower stations in our study (only seven). The “strain pole” types have been noted as being among the most dangerous ones, causing multiple electrocution incidents in other studies as well (DEMERDZHEV et al. 2009). We have confirmed that poles with “pin-type insulators” located parallel to each other (Type 1, Type 5) were extremely hazard-

ous for raptors (KOLNEGARI et al. 2021, SHOBRAK et al. 2022). Understandably, all electrocuted diurnal birds of prey found in our study were collected under such types of poles. Poles of similar types were also mentioned as particularly dangerous for raptors globally (FERRER et al. 1991, GUYONNE et al. 2001, BEKMANSUROV et al. 2012, ANGELOV et al. 2013, DEMERDZHIEV 2014).

The highest mortality recorded on the Al Mafraq line was due to dead White Storks under tower stations (transformers). A large number of electrocuted storks was also found on the lines of the Al Ekaider and Syria-Jordan Border. Al Ekaider is a dumpsite along migration route of White Stork and considered as an important stopover site for feeding used by thousands of storks. The Al Jafer Line in the Ma'an area appears to be one of the most hazardous lines for raptors, as all dead Egyptian Vultures, Steppe Eagles, Short-toed Snake Eagles, and Black Kites were found there. In this area, there are no records of existing dumps or slaughterhouse waste disposal sites (authors' data). It is likely that the availability of suitable prey, as well as the convenient perches provided by the hazardous electric poles used by raptors and storks for staging during their migration, are the reason for the high mortality along this line. The likely reason for finding so many dead birds of prey of various species in such a limited area is the location of this power line. It is found in open grounds that include different habitats such as desert and arable land, where the presence of prey attracts predators. On the other hand, the lack of trees encourages birds to perch on hazardous poles and significantly increases the risk of electrocution. Therefore, regions like Ma'an, being stopover sites for many raptors along their migration route, are extremely important for the species conservation, since in a very short time they could concentrate a large part of their populations, where persistent mortality due to any reason, for example electrocution, would have a serious deleterious population-level effect in the future.

Conservation mitigation

About 40% (n = 742) of the investigated hazardous electric poles of different types were insulated within the project "Urgent Actions to Strengthen the Balkan Population of the Egyptian Vulture and Secure Its Flyway" (LIFE16 NAT/BG/000874) (Table 2). However, all identified dangerous tower stations were insulated, as well as most of the "strain" pole types. When securing the power lines, priority was given to insulation of the grid in its entirety, as well as the more important sections of Al Jafer and the Syria-Jordan Border power lines.

Our expectations that bird electrocution mortality would be high in the study areas due to the location of the country on the flyway of many species, found full confirmation. Finding specimens of globally threatened species, such as the Egyptian Vulture and the Steppe Eagle, electrocuted in such a short time only in a small part of Jordan's territory, shows the gravity of the problem related to the mortality of these species in the region.

Therefore, to ensure a safe migration flyway for different globally threatened species such as the Steppe Eagle and the Egyptian Vulture, urgent measures are needed along the entire migration route involving both Jordan and neighbouring countries of the region. Collaboration with the energy companies should be intensified to provide best practice solution, such as gradual replacement of dangerous types of electric poles with safe ones or isolation of hazardous ones where it is impossible to replace them. We recommend also the intensification of similar research, in order to evaluate how serious the problem really is, identifying hotspots of electrocution mortality and implementing subsequent insulation of hazardous electricity infrastructure. This will inevitably contribute to the prevention of the dramatic decline in the populations of these species, as well as to their subsequent recovery.

Acknowledgments: This work was carried out in the frames of the projects "Egyptian Vulture New LIFE" (LIFE16 NAT/BG/000874, www.LifeNeophron.eu) funded by the European Union and co-funded by the A. G. Leventis Foundation and the MAVA Foundation; and Migratory Soaring Birds Project (phase II) funded by GEF / UNDP. We would like to thank the RSCN and Birdlife Middle East for logistics and coordination support, all the volunteers who participated in the field survey and all the employees who took part in insulating the hazardous power distribution network. We also express special thanks to the two anonymous reviewers for their relevant and valuable comments that improved the manuscript.

References

- ANDREWS A. 1990. Fragmentation of habitat by roads and utility corridors: a review. *Australian Journal of Zoology* 263 (4), 130–141. <https://doi.org/10.7882/AZ.1990.005>
- ANGELOV I., HASHIM I. & OPPEL S. 2013. Persistent electrocution mortality of Egyptian Vultures *Neophron percnopterus* over 28 years in East Africa. *Bird Conservation International* 23: 1–6.
- BALMORI A. 2015. Anthropogenic radiofrequency electromagnetic fields as an emerging threat to wildlife orientation. *Science of the Total Environment* 518: 58–60. <https://doi.org/10.1016/j.scitotenv.2015.02.077>
- BEKMANSUROV R.H., ZHUKOV D.V. & GALEEV A.S. 2012. Studding of bird electrocution on overhead power lines 6-10 kV in

- the territory of the Republic of Tatarstan to develop the step-by-step Regional Plan on Bird Protection: preliminary analysis of the results of autumn surveys of 2011. *Raptor Conservation* 24: 42–51.
- BERNARDINO J., BEVANGER K., BARRIENTOS R., DWYER J.F., MARQUES A.T., MARTINS R.C., SHAW J.M., SILVA J.P. & MOREIRA F. 2018. Bird collisions with power lines: State of the art and priority areas for research. *Biological Conservation* 222: 1–13. <https://doi.org/10.1016/j.biocon.2018.02.029>
- BUECHLEY E.R., OPPEL S., BEATTY W.S., NIKOLOV S.C., DOBREV V., ARKUMAREV V., SARAVIA V., BOUGAIN C., BOUNAS A., KRET E., SKARTSI T., AKTAY L., AGHABABYAN K., FREHNER E. & Şekerciöğlü Ç.H. 2018. Identifying critical migratory bottlenecks and high-use areas for an endangered migratory soaring bird across three continents. *Journal of Avian Biology* 49: e01629. <https://doi.org/10.1111/jav.01629>
- DEMERDZHIEV D. 2014. Factors influencing bird mortality caused by power lines within Special Protected Areas and undertaken conservation efforts. *Acta Zoologica Bulgarica* 66(2): 411–423.
- DEMERDZHIEV D., STOYCHEV S., PETROV Tz., ANGELOV I. & NEDYALKOV N. 2009. Impact of Power Lines on Bird Mortality in Southern Bulgaria. *Acta Zoologica Bulgarica* 61 (2): 177–185.
- DIXON A., MAMING R., GUNGA A., PUREV-OCHIR G. & BAT-BAYAR N. 2013. The problem of raptor electrocution in Asia: Case studies from Mongolia and China. *Bird Conservation International* 23(4): 520–529. doi:10.1017/S0959270913000300
- DWYER J.F., KARYAKIN I.V., Garrido López J.R. & Nikolenko E.G. 2023. Avian electrocutions on power lines in Kazakhstan and Russia. *Ardeola* 70: 3–27.
- FERNIE K.J. & REYNOLDS S.J. 2005. The Effects of Electromagnetic Fields from Power Lines on Avian Reproductive Biology and Physiology: A Review. *Journal of Toxicology and Environmental Health, Part B* (8): 127–140. <https://doi.org/10.1080/10937400590909022>
- FERRER M., DE LA RIVA M. & CASTROVIEJO J. 1991. Electrocutions of raptors on power lines in southwestern Spain. *Journal for Field Ornithology* 62. GNF.
- GONZÁLEZ L.M., MARGALIDA A., MAÑOSA S., SÁNCHEZ R., ORIA J., MOLINA J., CALDERA J., ARANDA A. & PRADA L. 2007. Causes and spatio-temporal variations on non-natural mortality in the vulnerable Spanish Imperial Eagle *Aquila adalberti* during a recovery period. *Oryx* 41: 495–502.
- GRIGGS D., STAFFORD-SMITH M., GAFFNEY O., ROCKSTRÖM, J., Öhman M.C., SHYAMSUNDAR P., STEFFEN W., GLASER G., KANIE N. & NOBLE J. 2013. Sustainable development goals for people and planet. *Nature* 495: 305–307. <https://doi.org/10.1038/495305a>
- GUIL F. & PÉREZ-GARCÍA J.M. 2022. Bird electrocution on power lines: spatial gaps and identification of driving factors at global scales. *Journal of Environmental Management* 301: 113890.
- GUIL F., SORIA M.Á., MARGALIDA A. & Pérez-GARCÍA J.M. 2018. Wildfires as collateral effects of wildlife electrocution: An economic approach to the situation in Spain in recent years. *Science in Total Environment* 625: 460–469. doi:10.1016/j.scitotenv.2017.12.242.
- GUYONNE F., JANSS E. & FERRER M. 2001. Avian electrocution mortality in relation to pole design and adjacent habitat in Spain. *Bird Conservation International* 11 (1): 3–12.
- KARYAKIN I. 2008. Problem “Birds and Power Lines”: some positive effect exist. *Raptor Conservation* 12: 11–27.
- KARYAKIN I.V. & NOVIKOVA L.M. 2006. The Steppe Eagle and power line in Western Kazakhstan. Is coexistence have any chance? *Raptors Conservation* 6: 48–57.
- KARYAKIN I.V. 2013. Review of the modern population status of the Steppe Eagle in the world and in Russia. *Raptor Conservation* 26: 22–43.
- KOLNEGARI M., CONWAY G., BASIRI A., PANTER C., HAZRATI M., RAFIEE M., FERRER M. & DWYER J. 2021. Electrical Components Involved in Avian-Caused Outages in Iran. *Bird Conservation International* 31(3), 364-378. doi:10.1017/S0959270920000507
- Lammers W. & Collopy M. 2007. Effectiveness of Avian Predator Perch Deterrents on Electric Transmission Lines. *Journal of Wildlife Management* 71 (8): 2752–2758. DOI:10.2193/2005-752
- LAZAROVA I., DOBREV D., GRADEV G., PETROV R., STOYCHEV S., KLISUROV I. & DEMERDZHIEV D. 2020. Main mortality factors for the Eastern Imperial Eagle (*Aquila heliaca* Savigny, 1809) in Bulgaria. *Ornis Hungarica* 28(2): 120–134. DOI: 10.2478/orhu-2020-002.
- LEHMAN R., KENNEDY P. & SAVIDGE J. 2007. The state of the art in raptor electrocution research: A global review. *Biological Conservation* 136 (2): 159–174. DOI: 10.1016/j.biocon.2006.09.015
- LÓPEZ-LÓPEZ P., FERRER M., MADERO A., CASADO E. & MCGRADY M. 2011. Solving man-induced large-scale conservation problems: the Spanish Imperial Eagle and power lines. *PLoS ONE* 6: e17196.
- MAINWARING M. 2015. The use of man-made structures as nesting sites by birds: A review of the costs and benefits. *Journal for Nature Conservation* 25: 17–22. <https://doi.org/10.1016/j.jnc.2015.02.007>.
- MAÑOSA S. 2001. Strategies to identify dangerous electricity pylons for birds. *Biodiversity and Conservation* 10: 1997–2012. <https://doi.org/10.1023/A:1013129709701>
- OPPEL S., ARKUMAREV V., BAKARI S., DOBREV V., SARAVIA-MULLIN V., ADEFOLU S., SÖZÜER L.A., APEVERGA P.T., ARSLAN Ş., BARSHEP Y., BINO T., BOUNAS A., ÇETIN T., DAYYOUB M., DOBREV D., DURO K., EL-MOGHRABI L., ELSAFOURY H., ENDRIS A., ASSWAD N.G., HARRY J.H., IVANDE S.T., JBOUR S., KAPSALIS E., KRET E., MAHAMUED B.A., MANU S.A., MENGISTU S., MOUSSA ZABEIROU A.R., MUHAMMAD S.I., NAKEV S., NGARI A., ONOJA J., OSTA M., ÖZUSLU S., PETROVSKI N., POPGEORGIEV G., POURCHIER C., QANEER T., RUFFO A., SHOBRAC M., SIDIROPOULOS L., SKARTSI T., SÖZÜER Ö., STARA K., TESFAYE M., TOPI M., VAVYLIS D., VELEVSKI M., VORPSI Z., WONDAFRASH M., XEKA E., YENIYURT C., YORDANOV E. & NIKOLOV S.C. 2021a. Major threats to a migratory raptor vary geographically along the eastern Mediterranean flyway. *Biological Conservation* 262: 109277. doi:10.1016/j.biocon.2021.109277
- OPPEL S., BUECHLEY E.R., LÓPEZ-LÓPEZ P., PHIPPS L., ARKUMAREV V., BOUNAS A., WILLIAMS F., DOBREV V., DOBREV D., STOYCHEV S., KRET E., CENERINI A., CECCOLINI G., SARAVIA V. & NIKOLOV S.C. 2021b. Egyptian Vulture *Neophron percnopterus*: In Migration Strategies of Birds of Prey in Western Palearctic. Eds Panuccio, M., Mellone, U., Agostini, N., pp. 22-34. CRC Press, Boca Raton, FL.
- OPPEL S., RUFFO A., BAKARI S., TESFAYE M., MENGISTU S., WON-

- DAFRASH M., ENDRIS, A., POURCHIER C., NGARI A., ARKUMAREV V. & NIKOLOV S.C. 2022. Pursuit of 'sustainable' development may contribute to the vulture crisis in East Africa. *Bird Conservation International* 32(2): 173–187. doi:10.1017/S0959270921000307
- PANUCCIO M., MELLONE U. & AGOSTINI A. 2021. Migration Strategies of Birds of Prey in Western Palearctic. CRC Press, Boca Raton, Florida, 320 p.
- SHOBRAK M., ALASMARI S., ALQTHAMI A., ALQTHAMI F., AL-OTAIBI A., AL ZOUBI M., EL MOGHRABI L., JBOUR S., ASSWAD N.G., OPPEL S., ARKUMAREV V. & NIKOLOV S.C. 2022. Electric infrastructure poses a significant threat at congregation sites of the globally threatened Steppe Eagle *Aquila nipalensis* in Saudi Arabia. *Bird Conservation International*, 32(2): 313–321. doi:10.1017/S0959270921000204
- SHOBRAK M., ALASMARI S., ALQTHAMI A., ALQTHAMI F., AL-OTAIBI A., AL ZOUBI M., EL MOGHRABI L., JBOUR S., ARKUMAREV V., OPPEL S., GHAZAL ASSWAD N. & NIKOLOV S.C. 2020. Congregations and threats of migratory Egyptian Vultures *Neophron percnopterus* along the southwest coast of Saudi Arabia. *Sandgrouse* 42: 248–258.
- TRYJANOWSKI P., SPARKS T., JERZAK L., ROSIN Z.M. & SKÓRKA P. 2014. A paradox for conservation: Electricity pylons may benefit avian diversity in intensive farmland. *Conservation Letters* 7(1): 34–40. <https://doi.org/10.1111/conl.12022>

Received: 31.03.2023

Accepted: 12.11.2023