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Electrocution of raptors at power lines in Central Kazakhstan

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Abstract

Along three transects of medium voltage power lines in the steppe of Central Kazakhstan, surveys for bird casualties were carried out in summer 2006 in order to estimate the quantitative and qualitative impact of power lines on bird mortality in this area. In total, 409 dead birds of 34 different species were found. Raptors represented 44 % of the total (179 individuals, 10 species). Most of them died due to electrocution. The proportion of raptors strongly varied between early and late summer, the increase in August suggests that especially young birds are prone to electrocution. The density of raptor casualties varied from 0.1 to 7.6 birds per line km and month. Adverse effects of power lines on bird life could be avoided by changing the pole construction (use of suspended insulators) or protective measures (e. g. caps).

Keywords: *bird casualties, birds of prey, collision, Kazakhstan, steppe*

Zusammenfassung

Zur Bestimmung des qualitativen und quantitativen Ausmaßes des Stromtodes von Vögeln in Zentralkasachstan wurden im Sommer 2006 Transektzählungen entlang von drei Mittelspannungsleitungen in dieser Region durchgeführt. Insgesamt wurden 409 tote Vögel (34 verschiedene Arten) gefunden, davon 44 % Greifvögel (179 Individuen, 10 Arten). Der Großteil starb durch Elektrokution. Der Anteil der Greifvögel variierte stark zwischen Früh- und Spätsommer. Der Anstieg im August lässt vermuten, dass Jungvögel besonders gefährdet sind. Die Greifvogeldichte betrug zwischen 0,1 und 7.6 Vögel pro Transekt-km und Monat. Durch veränderte Mastenkonstruktion (hängende Isolatoren) oder Schutzmaßnahmen (isolierende Hauben) kann viel zum Vogelschutz beigetragen werden.

Schlüsselwörter: Stromtod, Greifvögel, Kollision, Kasachstan, Steppe

1 Introduction

Throughout the world the availability of electricity is one of the key features of a high living standard. On its way from power plants to users, electricity is mainly transported via above-ground power lines. This „wiring“ of the landscapes and dangerous construction of medium voltage power lines by using upright insulators (instead of suspended ones) exposes birds to deathly risks (e. g. Haas 1980, Bevanger 1994, 1998, Lehman et al. 2007). These widely used constructions of above-ground power lines pose two major threats to birds (Janss 2000, Haas et al. 2003):

1. The **risk of electrocution**, i. e. birds sitting on power poles and/or conducting cables are killed when they cause short circuits (short circuit between phases or short-to-ground).
2. The **risk of collision**, i. e. birds in flight collide with the cables of power lines because these are difficult to perceive as obstacles.

Particular high numbers of bird casualties related to electrocution and collision have been recorded in open landscapes such as wetlands or grassland (Haas et al. 2003, Lehman et al. 2007). In the absence of trees in these habitats, birds of prey are especially attracted by power poles. These are used as lookout points, perching, roosting, and nesting sites (Karyakin et al. 2005, Infante and Peris 2003, Sánchez-Zapata et al. 2003). Various studies point out the negative consequences of electrocution respectively collision on a population level, e.g. for the Spanish Imperial Eagle (*Aquila adalberti*) (Ferrer et al. 1991), Eagle Owl (*Bubo bubo*) (Segio et al. 2004) and tetraonids (Bevanger 1995). There is evidence that increased mortality and population declines in Steppe Eagle (*Aquila nipalensis*) might have been caused by electrocution in Kazakhstan (Moseikin 2003). In our study, we focused on steppe habitats in Kazakhstan. We concentrated on the qualitative and quantitative assessment of the potential risk for birds which are exposed to power lines in this poorly studied area (Lehman et al. 2007). We used a transect count approach to gather baseline data for the development of strategies to minimize the risks for birds from power lines.

2 Study Area

The above described particularities of steppe habitats can be met throughout Central Asia. We chose the “Korgalzhyn State Nature Reserve“ (Zapovednik) and its surroundings which are part of the Tengiz-Korgalzhyn Lake System (50°25’N 069°15’E) as a study plot (nearest town: Korgalzhyn). The Tengiz area represents one of the most important stop-over sites for waterbirds on the Central Asian Flyway (Schielzeth et al. 2008). A number of threatened raptor species such as Greater Spotted Eagle (*Aquila clanga*), Eastern Imperial Eagle (*Aquila heliaca*), Lesser Kestrel (*Falco naumanni*) and Saker Falcon (*Falco cherrug*) can be found in adjacent steppe areas, especially during migration (Gavrilov 1999, Gavrilov and Gavrilov 2005). Its mosaic of numerous salt and fresh water lakes embedded in dry steppe landscape makes it a region of high public and conservation interest, particularly on an international scale. The area is protected since 1968, was declared a Ramsar Site in 1976, is part of the global “living lakes” network (GNF 2008, Wetlands International 2008), and was recently declared UNESCO World Heritage Site (Saryarka – UNESCO 2008).

Three different transects along medium voltage power lines (10–35 kV) with upright insulators, each around 15 km long, were chosen for our study. They run parallel to unpaved earth roads and are hereafter referred to as the nearest settlements, i. e. Arykty, Karazhar, and Korgalzhyn. The construction of the poles is the same at all three sites and the vegetation height and density is similar along the transects, so that the detectability of birds does not differ from site to site. In contrast to the more urban environment around Korgalzhyn,

Tab. 1: Anzahl der Todfunde entlang der drei untersuchten Transekte in Kasachstan. Ein Großteil der in der Rubrik „others“ zusammengefassten Vögel sind Krähen (*Corvus cornix* und *C. frugilegus*).

Tab. 1: *Number of casualties found in total along the three investigated transects in Kazakhstan during the study period from May to August 2006; mainly crows (Corvus cornix and C. frugilegus) account for the casualties summarized as „others“.*

	Number electrocuted						
	Arykty		**Karazhar**		**Korgalzhyn**		
Raptors (Accipitriformes)	**May+June**	**August**	**May+June**	**August**	**May+June**	**August**	Σ
Species							
Accipiter nisus	0	0	0	0	1	0	1
Aquila heliaca	1	0	0	0	0	0	1
Aquila spec.	0	3	0	0	0	0	3
Buteo buteo vulpinus	2	0	0	0	0	0	2
Buteo lagopus	1	0	0	0	0	0	1
Buteo rufinus	7	26	1	0	1	0	35
Buteo rufinus / buteo	1	8	2	0	1	1	13
Buteo spec.	0	4	1	2	0	0	7
Circus macrourus	0	7	0	0	0	0	7
Circus macrourus / pygargus	0	12	0	0	0	0	12
Falco cherrug	0	2	0	0	0	0	2
Falco tinnunculus	5	12	5	4	0	3	29
Falco tinnunculus / naumanni	10	40	0	9	0	2	61
Falco vespertinus	4	0	0	0	0	0	4
Milvus migrans	1	0	0	0	0	0	1
Σ Raptors	**32**	**114**	**9**	**15**	**3**	**6**	**179**
Others	122	15	34	24	23	12	230
Σ Total	**154**	**129**	**43**	**39**	**26**	**18**	**409**

the area around Karazhar is characterised by pristine steppe habitats and many (salt) lakes whereas around Arykty fields and mainly fallow land are predominant.

3 Material and methods

Field work was carried out in May and June 2006 (up to 5 surveys at each site) and additionally once again at the end of August 2006. During each survey, the whole length of the transect was examined by walking along the power line. Thus the bias of unequal detectability, depending on the size of the bird, was minimized. Every casualty found within a corridor of 10 metres width to both sides of the power line was marked with colour spray so that accidental double-counting during following visits was precluded. If possible, birds were aged and sexed according to their plumage features (Svensson et al. 1999). All birds classified as electrocution victims were found underneath or very close to the poles. Visual detectable injuries of the birds were carefully examined in order to identify electrocution.

4 Results

During all surveys combined, from May to August 2006, 409 casualties of 34 different species were recorded in total (electrocution and collision). Raptors accounted for 44 % (Table 1). Among these, especially falcons were affected, with 96 out of 179 individuals (54 %). In August, only four Common Kestrels (*Falco tinnunculus*) out of 70 individuals were adult males (the rest adult females and immature birds). Dead buzzards (*Buteo* spec.) were recorded quite frequently as well (32 % of all birds found dead). Although Pallid and Montague's Harriers (*Circus macrourus* and *pygargus*) usually do not perch on poles, 19 remains of these harriers were found; at least 15 of them were first calendar-year birds. Furthermore, one immature Eastern Imperial Eagle (*Aquila heliaca*) was found (species listed as Vulnerable – IUCN 2007) as well as three other eagles – probably Steppe Eagles (*Aquila nipalensis*). Additionally, two Saker Falcons (*Falco cherrug*), one of them a first calendar-year bird, were discovered. This species is considered worldwide as endangered (IUCN 2007).

There is a large regional variation in total numbers of casualties with 154 dead birds found near Arykty in May/June 2006 compared to 43 in Karazhar and 26 in Korgalzhyn, respectively (Figure 1). The results for August 2006 confirm this trend. Raptors, crows, and gulls together account for 93 % of all casualties. They are, besides small Passerines, among the most abundant steppe species in this area, so the probability to find those is higher than in other species. But also, they tend towards resting on poles and are therefore more vulnerable in regard to electrocution. Almost all raptor casualties were found directly underneath the poles. Only one collided raptor, a first calendar-year Long-legged Buzzard (*Buteo rufinus*), was recorded. Mainly nocturnal migrants such as waterfowl, waders, and song birds are especially prone to collide with power lines. For example two Baillon's Crakes (*Porzana pusilla*) were found dead. But their number plays only a minor role during our investigation since over 90 % of all casualties were killed by electrocution (Figure 1). In May and June, a total of 223 casualties (44 raptors) were recorded. During only one census at each site in August, 186 casualties (135 raptors) were recorded.

Two important changes were perceived during the summer period: (1) a distinct increase of casualties during the summer months and (2) the proportion of killed raptors increased distinctly, especially due to high numbers of perished Common / Lesser Kestrels (*Falco tinnunculus / naumanni*) (Table 1). These overall trends are documented for each investigated transect (Figure 1 and 2). Table 2 presents the corresponding densities of bird casualties per line km and month. In the Tengiz area, 0.1 (Korgalzhyn, May 2006) to 7.6 (Arykty, August 2006) raptors (0.9 to 8.6 birds in total) died per line km and month.

5 Discussion

In our study, we confirmed that electrocution represents a serious risk to birds, in particular to raptors. In August, almost twice as many bird victims were detected than in the preceding months (Table 1). This increase is mainly caused by raising numbers of electrocuted raptors and can probably be attributed to the dispersal of juveniles as well as to migration movements. Immature birds seem to be especially prone to electrocution. Not only single individuals but large numbers of young birds died by electrocution which is in accordance with the results of other studies (e. g. Janss and Ferrer 2001, Rubolini et al. 2001). Casualty densities averaged over all sites and the whole study period account for 1.3 raptors (3 birds in total) per km and month. This indicates an outstanding electrocution rate during the summer months. In other studies, much lower electrocution rates were stated. Rubolini et al. (2005) determined a median rate of 0.25 birds per km and month (3 birds per km and year) for different habitat types in Italy. Karyakin et al. (2005) reported densities of 0.56 raptors per km for one census carried out in May 2003 in western Kazakhstan.

Our own observations show that the carcasses of killed birds remain for some time beneath or near the pole. Even after two to three weeks most of the carcasses were still there. Ferrer et al. (1990) also dealt with the problem of "disappearing" casualties and concluded that after one month only 40 % of the original number are left. Since our census was carried out at least once a month probably an even higher proportion of the overall casualties was documented along the three transects.

We found that besides waterfowl also waders, passerines, etc. collide with power lines. These species are primarily small and therefore do not remain beneath the pole for a long time (Ferrer et al. 1990); probably because they are prone to dislocation by mammals and carrion-eating birds and their decay rate is much faster. This could be confirmed by this study since most small birds encountered only died recently prior to detection. Thus, a potential underestimation of small-sized casualties should be taken into consideration.

Since there is no difference in pole construction (and thus also in the potential danger) our data suggest that the total number of casualties depends upon the surrounding habitat quality. The denser a local bird population the higher the risk of electrocution of single individuals. Since the area around Karazhar and also Arykty is almost undisturbed, higher breeding densities of raptors e. g. Pallid Harrier and Short-

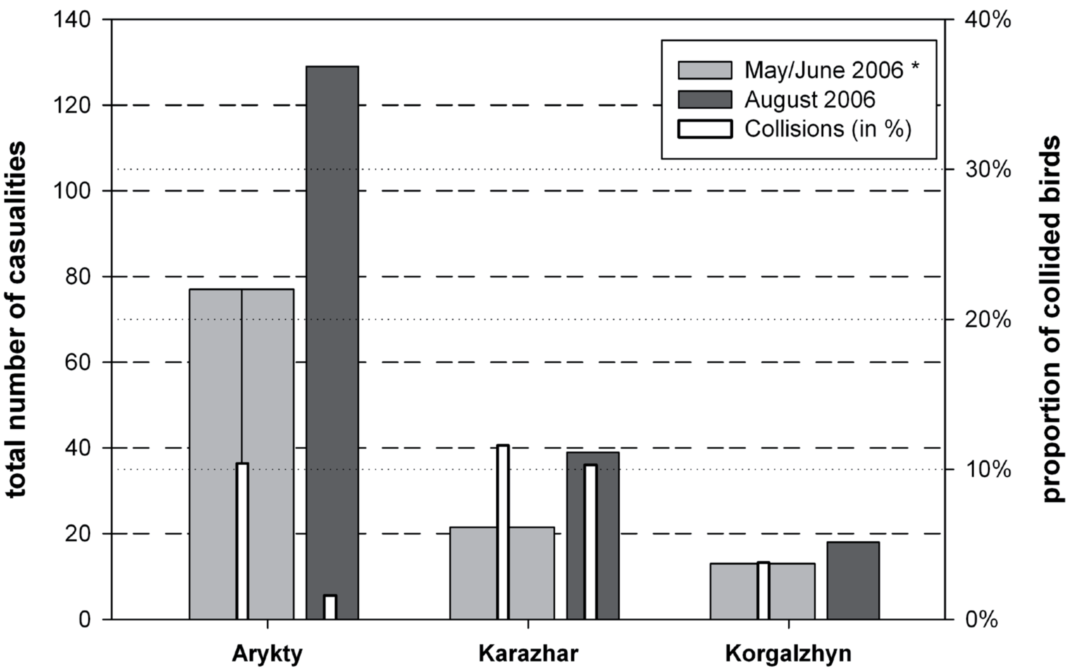

Abb. 1: Gesamtzahl tödlich verunglückter Vögel und Anteil der Kollisionen für die drei untersuchten Transekte in Kasachstan. *Monatsdurchschnitt

Fig. 1: *Total number of casualties and proportion of collision along the three investigated transects in Kazakhstan. *average per month*

Tab. 2: Durchschnittliche Todfunde pro km und Monat.

Tab. 2: *Casualties found averaged per line km and month.*

	Dead Birds per line km and month					
	Arykty		**Karazhar**		**Korgalzhyn**	
	May/June	**August**	**May/June**	**August**	**May/June**	**August**
Raptors	1,1	7,6	0,3	1,0	0,1	0,4
Total	5,1	8,6	1,4	2,6	0,9	1,2

eared Owl (*Asio flammeus*) in those habitats are likely. Three dead Short-eared Owls were found along the Arykty transect. Additionally, a colony of Rooks (*Corvus frugilegus*; about 300 breeding pairs) and a falcon colony composed of Common Kestrel (6 pairs) and Red-footed Falcon (*Falco vespertinus*; about 10 pairs) were found 7 km north from Arykty. Thus, besides juvenile dispersal, another reason for high numbers of casualties in Arykty could be accounted for by the nearby falcon colony and a gradation year of voles in 2006 (J. Kamp, pers. comm.) leading to high breeding success of all raptor species.

On the population level, it has been revealed that electrocution can severely affect highly threatened bird species like the Saker Falcon. Tucker and Goriup (2005) suggest that losses due to electrocution have a significant impact on populations of this species.

Since reliable data on local raptor populations are not available, it is hardly possible to determine the impact of these high electrocution rates on a local level. It is however known that electrocution has a negative impact on the global populations of not yet globally endangered species, e. g. Steppe Eagle, Long-legged Buzzard, and Common Kestrel (Tucker and Goriup 2005). Large Raptors follow the k-strategy (Meyburg et al. 2004) and therefore increased mortality has a large impact on the composition and size of populations (Rubolini et al. 2005). That is why the frequency of electrocution does not reveal the impact on the population level of a species. For rare species, the death of only some birds may already have significant consequences for the whole population. Bevanger (1994) points out towards the possible cumulative effects of various negative impacts on bird populations. Considering the reported high power line mortality (which comprises only a small fraction of the total numbers of birds killed by electrocution worldwide), he calls for raised public awareness and activities to mitigate adverse effects on bird life despite not always available data about effects on local populations (Bevanger 1998).

6 Conclusion

The investigated power lines (which belong to the most common construction type) pose a thread to birds. But it has to be pointed out that power lines are not necessarily dangerous to birds. It is the combination of badly engineered insulator and conductor constructions (which can be found especially on medium voltage power lines) on the one hand and of the attractiveness of power poles for many birds, especially raptors, on the other hand that explains the high risk posed to birds in our study area. On the short term, priority should be taken to apply safety measures (e. g. isolating caps) in sensible areas with high densities of breeding and migrating birds. On the long run, the overall aim should be to render all medium power lines safe in a feasible way. This can be achieved by different means which are outlined, e. g. by Haas and Schürenberg (2008) and Matsina (2008):

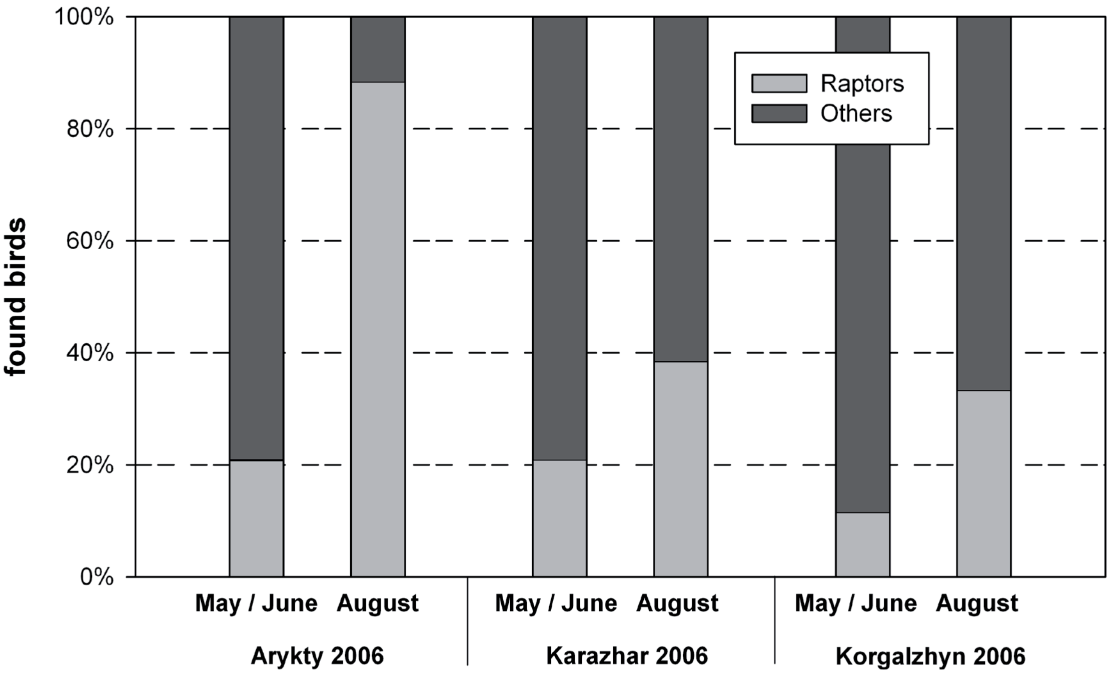

Abb. 2: Anteil der Greifvögel an der Gesamtzahl tödlich verunglückter Vögel für die drei untersuchten Transekte in Kasachstan.

Fig. 2: *Proportion of dead raptors found along the three investigated transects in Kazakhstan.*

- The modification of power lines (when they are reconstructed), e. g. by the use of suspended insulators,
- the cover of insulators with PVC caps, i. e. isolated tubing close to poles, and
- the reduction of power lines, e. g. by the introduction of alternative, local energy sources (e. g. solar energy in immediate proximity to the consumers).

Engineers of power supply companies should be aware of this danger to avian fauna. Accordingly, bird safety has to be considered when new poles are erected and unnecessarily dangerous constructions, viz. upright insulators, should be banned. Karyakin (2008) suggests that in Kazakhstan measures should be implemented at the state level, e.g. as in Germany where the construction of new „killer poles“ became generally prohibited and all existing power poles have to be rendered safe until 2012 (Federal Nature Conservation Act 2002: BNatSchG §53).

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