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A preliminary survey of avian mortality on power lines in the Overberg, South Africa

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Avian mortality on power lines in South Africa is currently recorded on the Central Incident Register (CIR), which is a collation of incidentally reported cases. The true scale of the problem is unknown, so we report here on a survey of representative power lines in the Overberg region of the Western Cape. On the 199 km surveyed, 123 birds of at least 18 species were found. Collisions were more common than electrocutions, apparently killing 88% of the birds found on distribution lines. Large terrestrial birds were the most numerous victims, with large numbers of Blue Cranes *Anthropoides paradiseus* and Denham's Bustards *Neotis denhami* killed. In comparison with mortality rates from the CIR, we estimate that only 2.6% of power-line mortalities are reported, emphasising the importance of systematic surveys in quantifying mortality and directing mitigation. Our survey highlights the general hazard that power lines pose to avifauna, and the urgent need for further research into the population impacts of the high incidence of collisions.

Introduction

The negative impact of electricity distribution infrastructure on birds through collisions and electrocutions is a well-recognised conservation problem (Bevanger 1998, Janss 2000). In South Africa, power lines are thought to have a significant impact on a number of threatened species (van Rooyen and Ledger 1999). All power in South Africa is distributed by Eskom, the national electricity utility. Currently, mitigation is directed on the basis of the Central Incident Register (CIR), which collates all wildlife mortalities reported by landowners, Eskom staff, members of the public and Endangered Wildlife Trust (EWT) fieldworkers on power infrastructure (Eskom–EWT Strategic Partnership 2008). However, the CIR is a collation of detected and reported records only. The fraction of total casualties it represents, and hence the true scale, nature and distribution of power-line-related mortality remains unknown. Comprehensive and systematic monitoring of collisions and electrocutions on a representative sample of power lines is essential to improve our understanding of these mortality factors, and our ability to mitigate their effects. Here, we report on the preliminary findings of such a monitoring effort in the Western Cape.

Materials and methods

The Overberg region of the Western Cape, South Africa, extends from 19–21° E and is bounded by mountain ranges to the north, and the ocean to the south (Figure 1). The landscape is characterised by coastal plains and rolling hills, with much of the native renosterveld, an evergreen fire-prone shrubland, transformed for cereal agriculture (Leeuwner et al. 2003, Mucina and Rutherford 2006). The Overberg wheatbelt is listed as an Important Bird Area (Barnes 1998).

Between September and December 2008, a single observer walked under a selection of distribution and transmission power lines in the vicinity of Caledon and Bredasdorp, searching the area 15 m to either side of the outer conductor for bird remains. Lines were chosen largely on the basis of accessibility and covered a variety of habitats. When a carcass was encountered, data on the line, location and carcass were collected following methods described by Anderson (2002). Position in relation to support pylons was recorded by dividing each span into five equal segments by eye to give three categories: midspan (central segment), close to pylon (segments adjacent to pylons) or in-between (Anderson 2002). The habitat in the Overberg is generally open, with tall vegetation only restricting the search in gullies or in ripe cereal fields. All remains found were removed to prevent double counting in subsequent surveys, and to aid in the identification of old or incomplete carcasses using comparative skeletal material. A short stretch of 7 km of line with an especially large number of carcasses was resurveyed in January 2009 to gather more information on mortality over time. Bird carcasses resulting from probable road kills, chicks fallen from nests and small birds found close to pylons (potential prey of corvids and raptors) were excluded from the results. All other bird carcasses found within the search corridor were assumed to have been either collision or electrocution victims. Carcasses of species known to use pylons as perches and found close to the pylon, on distribution lines only, were assumed to have been electrocuted. The transmission lines in the area are configured such that electrocutions are very unlikely (Figure 2).

To assess the distribution of carcasses, the surveyed power lines were broken into 250 m sections using the geographical

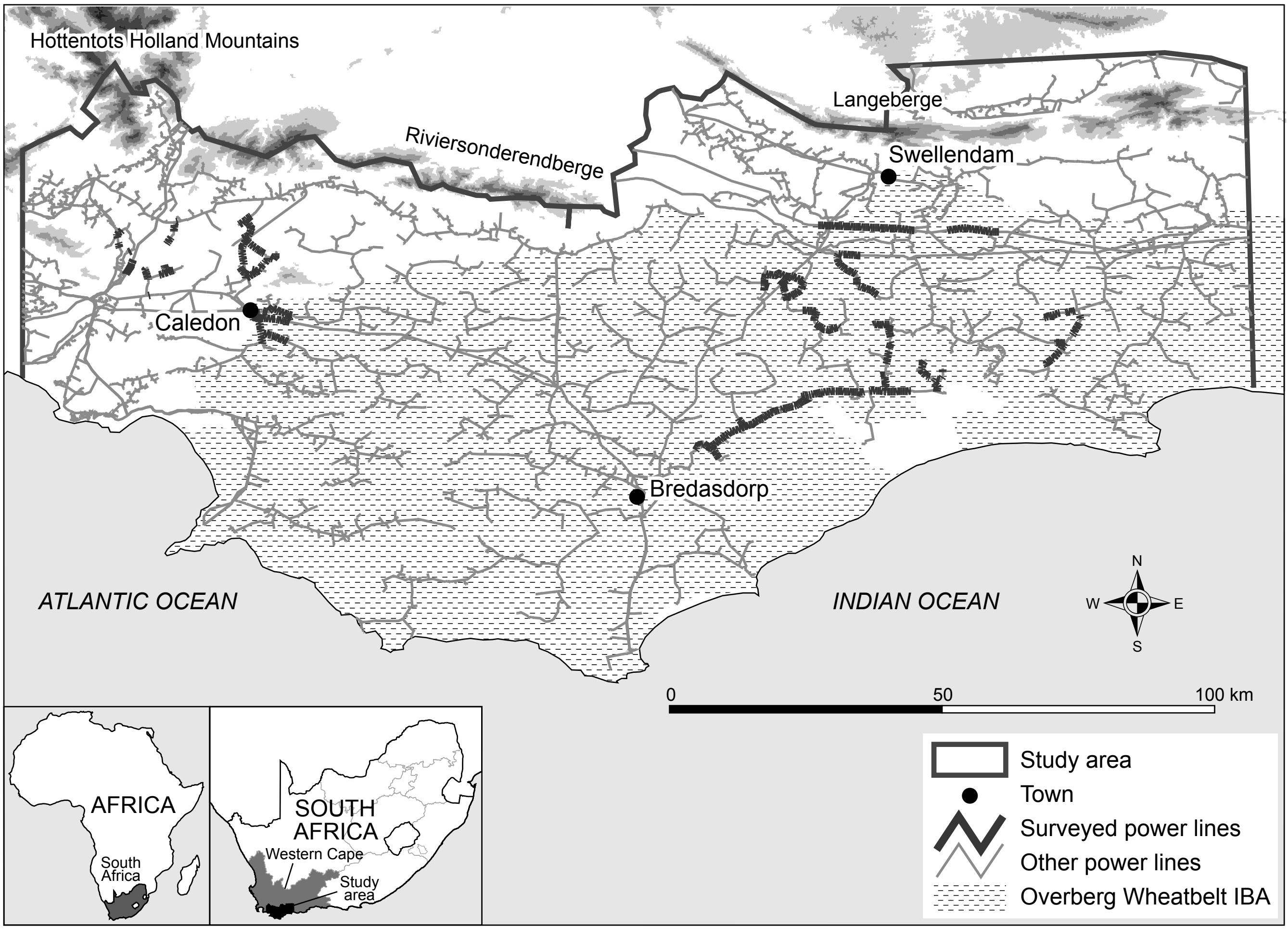

Figure 1: Study area in the Overberg region of the Western Cape, showing the regional power-line grid with surveyed lines in bold

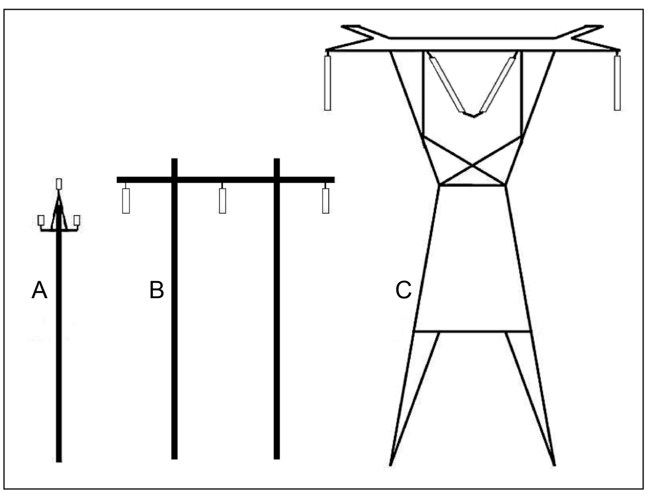

Figure 2: Typical configuration of (a) 11/22 kV distribution power lines, and (b) 66 kV and (c) 132/400 kV transmission power lines in the Overberg (not to scale), showing placement of conductors. Transmission lines also have overhead earth wires

information system (GIS) ArcView 3.2 (ESRI, Redlands). All carcasses recovered on the first survey only were associated with the nearest power-line section for analysis.

The CIR lists 297 avian mortalities associated with power infrastructure over 12 years in the entire Overberg study area (Figure 1) (Eskom-EWT Strategic Partnership 2008), which we converted to an average annual mortality per kilometre rate. To compare this with the mortalities found on our first systematic survey, we assumed these carcasses would persist for up to three years. We used this to convert carcasses found to an average annual mortality/km rate, which we then extrapolated to the length of power line in the entire area.

Results

In total, 199 km of power line (44 km of transmission line (66–400 kV) and 155 km of distribution line (11–22 kV)) were checked on the first survey, and the remains of 123 birds of at least 18 species were recovered (Table 1). On distribution lines, where both collisions and electrocutions can occur, most birds (88%) were apparently killed

Table 1: Number of suspected collision and electrocution victims of all species found during the initial survey of 199 km of Overberg power line, with average mass (Hockey et al. 2005)

Common name	Scientific name	Average mass (g)	Number of collisions	Number of electrocutions
Blue Crane	*Anthropoides paradiseus*	4 650–5 090	64	0
Denham's Bustard	*Neotis denhami*	3 700–7 600	18	0
Spur-winged Goose	*Plectropterus gambensis*	3 500–5 100	7	0
White Stork	*Ciconia ciconia*	3 500	5	1
Helmeted Guineafowl	*Numida meleagris*	1 380–1 500	4	3
Egyptian Goose	*Alopochen aegyptiaca*	1 870–2 350	2	3
Black-headed Heron	*Ardea melanocephala*	1 400–1 480	2	0
Southern Black Korhaan	*Eupodotis afra*	700	2	0
Barn Owl	*Tyto alba*	365–410	1	0
Cape Spurfowl	*Pternistis capensis*	770–980	1	0
Capped Wheatear	*Oenanthe pileata*	25	1	0
Grey-winged Francolin	*Scleroptila africanus*	430–450	1	0
Hadeda Ibis	*Bostrychia hagedash*	1 250	1	0
Lanner Falcon	*Falco biarmicus*	490–690	1	0
Red-capped Lark	*Calandrella cinerea*	24	1	0
Rock Dove	*Columba livia*	400	1	0
Sacred Ibis	*Threskiornis aethiopicus*	1 250	1	0
Cape Crow	*Corvus capensis*	500	0	2
Unidentified bustard/korhaan			1	0
Total			114	9

by collisions. Egyptian Geese and Helmeted Guineafowl dominated the small sample of electrocuted birds on these lines. Of the collision victims found on all lines, Blue Cranes were most numerous (57%), followed by Denham's Bustards (16%). The position of carcasses along the span was not random ($\chi^2 = 49.95$, df = 2, $P < 0.001$), with the midspan of the power line killing disproportionately more birds across all power-line voltages (Figure 3).

The distribution of collision carcasses attributed to power-line sections with GIS did not fit a Poisson distribution ($\chi^2 = 14.58$, df = 1, $P < 0.001$) with the variance ($\sigma^2 = 0.27$) exceeding the mean ($\mu = 0.15$), suggesting overdispersed data (Zar 1999). This clumped distribution of carcasses indicates collision hotspots. Hotspots were characterised by a variety of species and states of decomposition, with carcasses found on both sides of the line, suggesting that these sections were prone to repeated collisions rather than the result of a single event involving multiple birds. On the second survey of such hotspots, the carcasses of four White Storks, two Hadeda Ibises and one African Spoonbill *Platalea alba* were found on the 7 km of power line checked, all of which were assumed to have collided with the line. All but one of these birds (a White Stork) were killed along a 1.6 km section of line between October 2008 and January 2009.

The overall annual mortality rate is estimated to be 0.0054 birds km^{-1} from the CIR data, compared with 0.2060 birds km^{-1} from the data from our first survey. This suggests that only 2.6% of mortalities are actually reported. The same comparison based solely on Blue Crane mortalities gives an estimated reporting rate of 4.3% (annual collision rates of 0.0046 cranes km^{-1} from CIR data versus 0.1072 cranes km^{-1} from survey data). In addition, only 3.0% of the 297 mortalities listed on the CIR in the study area occurred on transmission lines, whereas the number of carcasses found on survey lines was twice as high on transmission as distribution lines (0.48 birds km^{-1} on distribution lines and 1.09 birds km^{-1} on transmission lines).

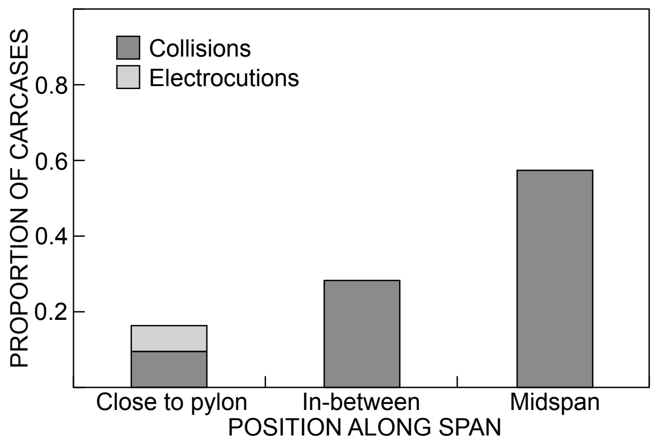

Figure 3: Proportion of carcasses found in each span position, weighted to adjust for the relative length of spans. Suspected collisions and electrocutions for all data (n = 128, two carcasses could not be assigned to a span position) from the initial survey of 199 km and subsequent survey of 7 km of Overberg power line

Discussion

Of the collision victims found in the Overberg, large terrestrial birds were most frequently represented, which is consistent with analysis from other parts of the world (Janss 2000). Their high collision potential results from their lack of manoeuvrability in flight, which renders them unable to avoid unexpected obstacles (Bevanger 1998). However, a variety of species of varying sizes was found, including small birds (c. 25 g). This is despite the expected higher removal rate by scavengers and the lower detectability of small carcasses (Bevanger 1999), highlighting the wider impact that power lines have on avifauna in the area. Although this mortality is unlikely to be biologically significant for many species recovered in this study, it may be important in areas inhabited by threatened species with small populations, regardless of their body size.

The central three-fifths of the span caused by far the majority of collision casualties, as has been found on power lines in the eastern Karoo (Anderson 2002). This is probably because these sections are less visible than the line close to pylons. The clumped distribution of carcasses found in this study supports the notion that collision hotspots are at least as much a function of line placement and design as they are of species-specific biology, perhaps because some areas act as general flyways due to topography, for example (Bevanger 1994). Concentrating on locating and marking these areas may be more efficient than implementing a large-scale mitigation scheme (Rubolini et al. 2005). Identifying the biological, meteorological, topographical and technical factors that interact on the sections of power line with collision hotspots is crucial in facilitating this type of selective mitigation.

Our systematic survey covered a substantial and representative sample of power lines of different voltages and configurations in different habitats, and is therefore suitable data to extrapolate across the study area. In comparison with the CIR, the overall number of carcasses that we found is very high, even for conspicuous Blue Cranes. In addition, while only a small fraction of mortalities listed on the CIR in the study area occurred on transmission lines, we found higher mortality rates on transmission than distribution lines. Despite this, all types of line are likely to have substantial negative impacts on the Overberg avifauna because of the extensive distribution network (3 855 km of distribution lines compared with 815 km of transmission lines in our study area), but these results emphasise the importance of systematic power-line searches in mortality estimates and directing mitigation, and the danger of using incidental records for such purposes.

Of the species found, the numbers of Blue Crane and Denham's Bustard carcasses are of the greatest conservation significance. Globally, the Blue Crane is listed as Vulnerable and Denham's Bustard as Near Threatened (BirdLife International 2008), although the latter is also nationally Vulnerable (Barnes 2000). The large numbers of these species found echoes results from the only other dedicated survey conducted in South Africa, in which Blue Cranes and Ludwig's Bustard *Neotis ludwigii* were the most numerous casualties found along transmission lines in the eastern Karoo (Anderson 2002). Current population estimates for Blue Cranes and Denham's Bustards in the Overberg are lacking, and are necessary to fully understand the biological significance of this mortality. However, preliminary Blue Crane collision rates estimated from our surveys suggest that power-line mortality may be sufficient to jeopardise the critical Overberg population (Shaw et al. in press). There is clearly urgent need for further research into the magnitude of this mortality, especially in the Overberg region, which represents an important area for both of these threatened species as they decline across the rest of their range (Allan 2005, McCann et al. 2007).

Almost half of the White Stork carcasses were found on the second survey of collision hotspots in January, when the density of storks in the Overberg was noticeably higher, suggesting that the migratory population had arrived between the surveys. This high seasonal toll supports findings that utility structures cause significant mortality to this species (van Rooyen and Ledger 1999). A study in Spain estimated that 1% of the population during post-breeding migration, and 5–7% of the population during winter, die on power lines (Garrido and Fernández-Cruz 2003). As with our results, this study recorded both collisions and electrocutions for this species. Severe losses have also been recorded for reintroduced populations in northern Italy (Rubolini et al. 2005), indicating that power lines pose a general threat to White Storks across their range. While the species is not currently considered threatened, this mortality may become more significant in light of recent population and breeding range declines (Anderson 2005).

In conclusion, the diversity of bird species found dead under Overberg power lines highlights the general hazard posed by these structures to local avifauna. The large numbers of large terrestrial birds recovered is of serious concern, especially in light of the proposed expansion of the power grid in this area, and in South Africa more generally (Eskom 2009). While relatively few electrocution victims were found, the high incidence of bird collisions highlights the urgent need for more widespread mitigation for this unnatural source of mortality. More detailed repeat surveys and censuses will provide a better understanding of the population impacts of power-line collisions and electrocutions and provide further insight into seasonal rates, and losses sustained by migratory species.

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