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RAPTOR USE AND ABUSE OF POWERLINES IN SOUTHERN AFRICA

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Powerlines pose problems to raptors when they nest, roost, collide with or are electrocuted by electricity wires and their supporting structures. Raptors gain advantage from nesting and roosting on electricity towers, while eagles and vultures are killed by flying into wires or being electrocuted on towers. Collisions are not known to be a problem for raptors in southern Africa, but electrocution is a serious mortality factor for vultures and eagles. The problems inevitably arise from the design of the electricity structures, and all new powerlines in Africa should be designed to bird-friendly standards. Various methods are available to retrospectively modify dangerous structures but they are both time-consuming and expensive.

RAPTORS AND POWERLINES

Although this paper concerns itself with southern Africa, it is noteworthy that only one paper has been published about raptor mortality on powerlines elsewhere in Africa. Nikolaus (1984) recorded the electrocution of at least 55 Egyptian Vultures (*Neophron percnopterus*) and four Lappet-faced Vultures (*Torgos tracheliotus*) in Sudan in 1982 and 1983. There must be countless interactions between raptors and powerlines in Africa, yet they remain undocumented. There is one report that includes details of raptors nesting on transmission towers in Namibia (Brown and Lawson 1989) but all other published information on the subject is from South Africa, where one utility, Eskom, supplies 90% of the country's electricity (as well partial supplies to neighboring states of Botswana, Lesotho, Mozambique, Namibia, Swaziland and Zimbabwe). Eskom generates more than 50% of the electricity consumed on the African continent (Eskom 1991), and operates a vast national grid of 765, 400, 275, 132, 88 and 66-kV transmission lines, and a rural distribution system of 22 and 11 kV on woodpole construction, estimated to comprise some 60 000 km. Africa is home to a large variety of raptors, some of which, like large eagles and vultures (Mundy et al. 1992) are particularly susceptible to electrocution on powerlines.

Prior to 1977, there was no systematic recording of raptor and powerline interactions on Eskom's network. Dean (1975) published the first records of Martial Eagles (*Polemaetus bellicosus*) nesting on transmission towers, while Markus (1972) had earlier recorded the mortality of Cape Griffons (*Gyps coprotheres*) by electrocution on 88-kV towers. As part of an ongoing research program on the Cape Griffon, the problem of electrocution was examined (Ledger and Annegarn 1981) and in 1977, a mutually beneficial association between the Endangered Wildlife Trust and Eskom was entered into which has endured to the present. Eskom established a bird research committee, now known as Eskom's Wildlife Impacts Advisory Committee (EWIAC). This group started collecting data on bird-powerline interactions in a systematic way and encouraged outside research workers to undertake projects of their own.

Today, there is a large body of information available about raptors and powerlines (Allan 1988, Boshoff 1993, Hobbs and Ledger 1986a, 1986b, Hobbs et al. 1990, Ledger 1983, 1984, Ledger and Hobbs 1985, Ledger et al. 1987). Eskom has published its own Bird Identification Guide (Ledger 1988) for maintenance personnel that summarizes the problems and solutions. EWIAC meets biannually but urgent matters are dealt with on an ad hoc basis by J.A.Ledger, who serves as a consultant to Eskom. EWIAC was originally a problem-solving committee, but with the devolution of environmental responsibility to the various operational regions (or business units), the problems are being solved at this level and the biannual meetings provide an opportunity for information-sharing.

SOLVING PROBLEMS OF RAPTORS AND POWERLINES

Prior to the establishment of Eskom's bird research committee in 1977, it was normal practice for all nests to be removed from transmission towers during annual maintenance, regardless of their contents. Apart from the costs of such unnecessary work to Eskom, this must have caused widespread raptor mortality. The opportunity for introducing some biological thinking into an engineering environment arose through the meetings of the committee. It was pointed out that problems of birds nesting on towers normally occur during the early phases of nest building, when long branches and sticks, or even pieces of wire may fall from the crossarm onto the conductor below, causing a flashover. Once nests are constructed and occupied, raptors will use them for years, and generally maintain them in good condition.

The removal of nests from towers by Eskom maintenance personnel was subsequently prohibited, except in those cases where the nest was collapsing and posed a direct threat to the electricity supply. Since this new approach to nest conservation has been adopted, a wide variety of raptors including Tawny Eagles (*Aquila rapax*), Black Eagles (*Aquila verrauxii*, Ledger et al. 1987), Martial Eagles, African Hawk Eagles (*Hieraaetus fasciatus*), White-backed Vultures (*Gyps africanus*, Ledger and Hobbs 1985), Lanner Falcons (*Falco biarmicus*), Greater Kestrels (*Falco rupicoloides*) and Rock Kestrels (*Falco tinnunculus*) are now breeding on transmission towers. The first five species construct their own nests, while the three *Falco* species use nests originally built by eagles or crows. If long sticks project below the nest, the solution is to trim them away during maintenance work, to prevent the occurrence of flashovers in wet weather. Should a nest containing young start to collapse because of wind, the whole structure can be secured to a wooden platform with wire, and the raptors will continue to feed their chicks. This has been done successfully with a Black Eagle nest in the Karoo. Although nesting platforms have been used successfully in the U.S., we have found that raptors do not readily use them in southern Africa and seem to have very definite preferences for making their own decisions about which towers they will select.

The value of electricity transmission towers as nesting sites for raptors is highlighted in a recent paper by Boshoff (1993). He monitored 7–18 pairs of Martial Eagles breeding in Eskom transmission towers in the Nama-Karoo over a period of 5–10 yr. This was done by making an annual series of flights in fixed-wing aircraft along 420 km of powerline. Mean linear density was 1 pair/19 km and mean minimum territory size was 284 km^2. Lack of marked variation in annual breeding effort indicated that the population was stable. Breeding success was 0.70 (eggs to nestlings) and 0.62 (breeding attempts to nestlings). Overall minimum reproduction rate was 0.52 young/pair/yr. Boshoff (1993) concluded that Martial Eagles obtain increased breeding success on electricity transmission towers. He suggested that persecution of birds on towers may be less than for birds nesting in low trees or the large boulders and low cliffs found in the Nama-Karoo. Safety from predators was also a factor, as towers provide a nesting substrate inaccessible to mammalian predators, including man. Boshoff also recounted the case of a pair of Martial Eagles which nested in a highly vulnerable position in a tree on a low cliff. They built a new nest on an Eskom tower within one year of the construction of the powerline.

The only raptors that roost in any numbers on Eskom towers are vultures, and in certain parts quite large numbers of (up to 100) Cape Griffons, sometimes with a few White-backed Vultures, roost over a number of towers of a transmission line. A few problems arising from the pollution of insulators with excreta from the birds have been encountered. The only solution has been to fit shields above the insulator strings, but the roost may move elsewhere along the line, depending on the availability of carrion. In a few cases, it proved necessary to wash the insulators from a helicopter which was a very expensive undertaking. It has also been found that V-string insulators are much more susceptible to pollution by vulture excreta than straight strings, and that a rubber dustbin lid makes a very good shield for the latter.

Some birds will collide with overhead wires all the time. The impact of this depends on the frequency of occurrence and the effects of the mortality on the particular species of bird. There is no evidence of any raptor being seriously at risk from collision with overhead wires in southern Africa. Where raptors are consistently at risk, the conductors can be marked using PLP Bird Flight Deflectors. These are plastic spirals which clip onto the wires and make them visible to the birds.

Electrocution of Cape Griffons on 88-kV transmission towers in the western Transvaal was due to the incompatibility of a large bird with a dangerous design, the so called 'kite construction.' Vultures were killed by landing on the crossarm of the tower and contacting a conductor with their extended wings. A 3-yr study identified the specific problem areas, and perches were fitted to several hundred towers. This largely solved the problem but, where it persisted due to high densities of roosting vultures, PVC spirals were fixed to the middle conductor around the insulator clamp to create a barrier to wing tips touching conductors at the moment of landing. The 'kite construction' has been outlawed for use in rural areas.

A more insidious problem has been the electrocution of raptors on 11 and 22-kV lines, of which an estimated 60 000 km cross rural terrain within South Africa, while Botswana, Lesotho, Namibia, Swaziland and Zimbabwe also have extensive networks of similar design. The majority of these lines were constructed on wooden poles with a horizontal crossarm bearing the conductors on pin or post insulators above the crossarm. In many cases, an earth downlead for lightning protection runs up the pole and terminates in a spike between the middle and an outer insulator. The potential for phase to phase, or phase to earth electrocutions on such structures is clearly great particularly with the information available from the U.S. (Olendorff at al. 1981), yet very little information on raptor mortality has accumulated over the years that EWIAC has been active.

A recent questionnaire survey conducted in the Colesberg district of the Eastern Cape Region (Ledger et al. 1992) elicited the following raptor electrocution figures from 55 respondents: 21 Martial Eagles, 20 Black Eagles, 20 vultures (of which four were Cape Griffons); 15 'eagles,' 6 'hawks,' 6 'owls,' and 2 Jackal Buzzards.

An unexpected finding from the survey was the extent to which raptors are electrocuted on terminal structures in rural areas. On many farms, there may be a number of such structures where the overhead line terminates at a transformer to supply a water pump or other equipment. The terminal structure is usually a twin-pole design with a horizontal crossarm bearing three strain insulators for the incoming conductors. Jumper leads from these three conductors go downward to connect to the transformer, while another three jumper leads go above the crossarm to connect to the lightning arrestors. The crossarm is bonded and earthed, and any bird which perches on the crossarm and touches one of the jumpers is electrocuted.

The solution to these hazards is relatively simple, but time-consuming and labor-intensive. Intermediate structures can be made safe by cutting a 500-mm gap in the earth downlead (or removing the earth spike completely and terminating the downlead just below the crossarm braces), in conjunction with insulation of the middle phase conductor. This can be achieved by fitting the locally developed RP 3 Raptor Protector (Ledger 1992), or by fitting a length of split XLPE (cross-linked polyethylene) tubing to the middle phase conductor.

To make the terminal structures safe for raptors, split XLPE insulation must be fitted to all the jumper leads above the crossarm, and it is also good practice to do the same to the jumpers running to the transformer. On new structures, insulated conductors should be used for all jumpers. Lightning arrestors are now fitted on the transformer rather than the crossarm.

Eskom management agreed in 1991 to direct that only bird-friendly designs should be used in rural areas in the future. The design of choice is the single pole with staggered insulators, as described by Hobbs et al. (1990), although an equally good design is one where the outer conductors hang below the crossarm on suspension insulators. Of great concern is the ongoing construction of bird-unfriendly powerlines throughout Africa.

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