Birds and electricity transmission lines in South West Africa/Namibia

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ABSTRACT

1447 km of 330 kV and 220 kV electricity transmission lines in South West Africa/Namibia were surveyed from a helicopter. Only one collision victim, a secretarybird *Saqittarius serpentarius,* was found, and there was no evidence of bird electrocution. Six raptor species and three passerines were found breeding on transmission towers. Blackbreasted snake eagles *Circaetus gallicus,* pale chanting goshawks *Melierax canorus* and greater kestrels *Falco rupicoloides* were the most common raptors, but the overall raptor inter-nesting distance (mean of 76 km) was large. The only power distributions due to birds were on 220 kV lines where these passed close to large water impoundments; "flashovers" occurred when fish-eating species excreted onto insulators.

INTRODUCTION

A network of over 5 000 km of electricity transmission lines of 66 kV to 330 kV carries power from the generating stations to the most important points of consumption in South West Africa/Namibia (van der Merwe 1983). The powerlines and their supporting towers (pylons) cross most of the vegetation types of the country, extending from the Namib coast in the west to the Kalahari in the east, and from the Cunene River in the north to the Orange River in the south (Figure 1). Because the best potential for power generation is in the extreme north of the country (hydroelectricity), far from the points of highest consumption, large overhead cables will be a part of our landscape for many years to come.

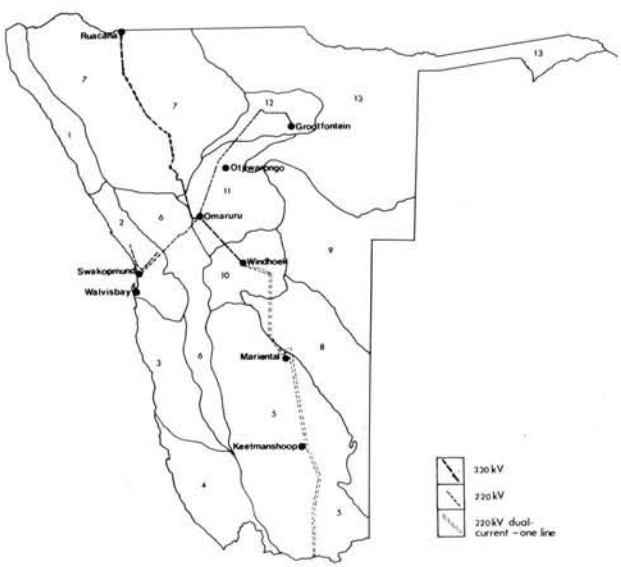

FIGURE 1: Localities of the 330 kV and 220 kV transmission lines in SWA/Namibia showing those sections surveyed, and the vegetation types (after Giess 1971) through which they pass. Regions 1, 2 & 3 = Northern, Central and Southern Namib (<100 mm of rainfall per annum), 4 = Southern winter rainfall Namib (<100 mm), 5 = Dwarf Shrub Savanna (100–200 mm), 6 = Desert-Savanna Transition (100–200 mm), 7 = Mopane Savanna (300–400 mm), 8 = Southern Kalahari Savanna (200–300 mm), 9 = Camelthorn Savanna (300–400 mm), 10 = Highland Savanna (300–400 mm), 11 = Thornbush Savanna (400–500 mm), 12 = Mountain Savanna (500–600 mm), 13 = Woodlands (400–600 mm).

Electricity brings obvious advantages to a developing country, but there are a number of ecological interactions associated with electricity transmission in overhead cables that have been identified in other countries and which should not be overlooked. These interactions can be divided into three main groups.

Negative ecological factors

a) Birds collide with overhead cables. This has been reported frequently for waterfowl in areas where powerlines pass near wetlands, *e.g.* Heijnis 1980; Longridge 1986; Rusz *et al.* 1986, but has also been reported elsewhere, involving a number of rare and endangered species, *e.g.* white stork *Ciconia ciconia* (Cramp & Simons 1977; Fiedler & Wissner 1980; Oatley & Rammesmayer 1988), greater *Phoenicopterus ruber* and lesser *P. minor* flamingoes (Brooke 1984; Hobbs & Ledger 1986), wattled crane *Grus carunculata* (Johnson & Sinclair 1984), European griffon *Gyps fulvus* (Terrasse 1983) and California condor *Gymnogyps californianus* (Snyder 1983).

b) Some bird species are electrocuted on towers while landing and taking off. The best document case in southern Africa involves the endemic Cape vulture *Gyps coprotheres* (*e.g.* Markus 1972; Ledger 1980, 1984; Ledger & Annegarn 1981; Hobbs & Ledger 1986). On a section of about 140 km of transmission lines in the Transvaal Province, 165 vultures were electrocuted in three years. Many other large species have been similary affected, *e.g.* European griffon (Terrasse 1983; Mendelssohn & Leshem 1983; Leshem 1983 – a quarter of Israel's northern population was electrocuted in two years), Egyptian vulture *Neophron percnopterus* (Nikolaus 1984), lappetfaced vultures *Torgos tracheliotus,* white and black *Ciconia nigra* storks and golden eagles *Aquila chrysaetos* (Fiedler & Wissner 1980; Haas 1980; Leshem 1985), martial eagles *Polemaetus bellicosus* (Brooke 1984) and black eagles *A. verreauxii* (Boshoff & Fabricius 1986).

c) Powerlines are unsightly, and particularly in nature reserves, they are aesthetically unacceptable.

Positive ecological factors

a) Some birds nest on the towers of transmission lines. These towers provide birds with secure, high nest sites and in some cases have allowed species to expand their breeding range into areas where no natural nesting sites occur (Newton 1979), *e.g.* martial and black eagles in the Karoo (Boshoff 1986; Boshoff & Fabricius 1986; Ledger *et al.* 1987). Table 1 lists the species that have been recorded nesting on electricity towers in southern Africa.

TABLE 1: Bird species that have been reported to nest on electricity transmission towers in southern Africa.

Species	Source
Hadeda Ibis *Bostrychia hagedash*	Legder & Hobbs 1985
Egyptian Goose *Alopochen aegyptiacus*	Ledger & Hobbs 1985
Whitebacked Vulture *Gyps africanus*	Legder & Hobbs 1985
Black Eagle *Aquila verreauxii*	Boshoff & Fabricus 1986 Legder *et al.* 1987
Tawny Eagle *Aquila rapax*	Dean 1975; Tarboton & Allan 1984
African Hawk Eagle *Hieraaetus fasciatus*	Tarboton & Allan 1984
Martial Eagle *Polemaetus bellicosus*	Dean 1975; Boshoff *et al.* 1983; Tarboton & Allan 1984
Lanner Falcon *Falco biarmicus*	Kemp 1972; Tarboton & Allan 1984
Rock Kestrel *Falco tinnunculus*	Boshoff *et al.* 1983
Greater Kestrel *Falco rupicoloides*	Kemp 1978, 1984
Black Crow *Corvus capensis*	Kemp 1984; Ledger & Hobbs 1985
Pied Crow *Corvus albus*	Kemp 1984; Ledger & Hobbs 1985

b) Many birds roost (overnight) and perch on transmission lines and towers (*e.g.* Ledger 1980, 1988; Ledger & Annegarn 1981; Steyn 1982; Kemp 1984). These structures provide the birds with a secure perch as well as an elevated position from which to hunt for prey.

Negative economic factors

a) Roosting birds may excrete onto insulators supporting transmission cables and thereby reduce their insulating properties and cause "flashovers", thus disrupting supply. This has been found mainly with ibises, herons and egrets near wetland areas (Ledger 1980, 1988; Hobbs & Ledger 1986).

b) Electrocution of birds can cause disruptions in electricity supply ranging from momentary interruptions due to impedence faults from phase to earth, or overcurrent faults due to overloading of a phase, to long interruptions of many hours because of damage to conductors (Ledger 1984, 1988).

c) Large nest structures, particularly when wet after rainfall, can similarly cause flashovers and may ignite, disrupting the power supply and possibly damaging equipment.

It was therefore decided to investigate electricity transmission lines and towers in SWA/Namibia to determine (a) to what extend, if any, these structures were leading to electrocution and collision in birds, (b) what species were in turn using the structures for nesting and perching and (c) what disruptions these activities were having on the electricity supply of the country.

METHODS

Opportunistic use was made of transit flights by helicopters under contract of the SWA/Namibia Directorate of Nature Conservation (a Bell 47 and a Bell Jet Ranger) to survey the large 330 kV and 220 kV electricity transmission lines where these lines coincided with routes to and from scheduled destinations. The crew consisted of a pilot and one observer. Normal survey height was about 20 m above the top of the steel towers and about 30 m to one side, flying parallel to the lines on the downwind side. For closer inspections of particular sites and to photograph nests, slow passes were made, or the aircraft was held stationary in the appropriate position.

A total of 1 447 km of transmission lines were surveyed on four routes, including 3106 support towers (Figure 1; Table 2). The following data were recorded:

(a) habitat type (after Giess 1971),
(b) design of support tower and voltage rating (see Figure 2),
(c) the precence or absence of electrocution victims at the base of each tower,
(d) collision victims in the strip below the transmission lines,
(e) nests in the transmission towers. The bird species involved was recorded as well as the position of the nest in the tower,
(f) all species perching on the towers or cables of about rock kestrel *Falco tinnunculus* size or larger, together with their position.

Reports of the South West Africa Water and Electricity Corporation (SWAWEC) referring to causes of power disruptions each month were analysed covering the two-year period 1986 and 1987.

RESULTS

Electrocution and collision

Three different steel tower structures (Figure 2) were examined during this survey, covering 687 towers of design A, 1 413 of design B and 1 006 of design C. No electrocution victims were found.

The survey covered 1 447 km of transmission lines, about 70% of the total length of all 330 kV and 220 kV lines in this country, in seven different vegetation

TABLE 2: Transmission lines surveyed from a helicopter (see Figure 1) with dates, times, distances, tower design (Figure 2) and numbers of towers.

Route (aircraft)	Date	Time	Distance (km)	Speed (km/h)	Tower design	Number of towers
1. Rossing (42 km ENE of Swakopmund) to Gerus (26 km NW of Otjiwarongo) (Bell 47)	15/08/86	13h50 to 16h40	335	150	A 220 kV	687
2 Grunau to Hardap Dam (Bell 47)	19/10/86	10h45 to 15h00	412	130	B 220 kV	833
3. Hardap Dam to Windhoek (Bell 47)	21/10/86	07h10 to 11h45	278	152	B 220 kV	580
4 W boundary of Etosha (18°52'S/14°38'E) to Okahandja (Bell Jet Ranger)	22/04/87	11h45 to 14h50	422	153	C 330 kV	1006
TOTALS	4 days	10 h*	1 447	145		3 106

* Number of flying hours along transmission lines excluding ferry time to the lines and refueling times.

TABLE 3: Bird species recorded nesting on electricity transmission towers during aerial surveys and the numbers of nests, in seven vegetation types in SWA/Namibia (see Figure 1).

	Vegetation types							
	2	**5**	**6**	**7**	**8**	**10**	**11**	**Totals**
Transmission lines surveyed: Distance (km)	50	534	97	236	62	94	374	1 447
: No. towers	103	1 080	198	554	121	212	838	3 106
Species								
Brown Snake Eagle *Circaetus cinereus*	–	–	–	–	–	–	1	1
Blackbreasted Snake Eagle *Circaetus gallicus*	–	3	–	2	–	–	–	5
Pale Chanting Goshawk *Melierax canorus*	–	3	–	–	–	–	–	3
Lanner Falcon *Falco biarmicus*	–	2	–	–	–	–	–	2
Rock Kestrel *Falco tinnunculus*	–	2	–	–	–	–	–	2
Greater Kestrel *Falco rupicoloides*	–	3	–	–	–	–	–	3
Unidentified raptor nest	1	1	1	–	–	1	–	4
Totals for raptors	1	14	1	2	0	1	1	20
Totals per 100 km	2,0	4,6	1,0	0,8	0	1,1	0,3	1,4
Black Crow *Corvus capensis*	–	6	3	2	–	–	–	11
Redbilled Buffalo Weaver *Bubalornis niger*	–	26	39	280	4	308	871	1 528
No. RBBW nests / 10 towers	0	0,2	2,0	5,1	0,3	14,5	10,4	4,9
Social Weavers *Philetairus socius*	–	13	2	–	117	–	–	132
No. SW nests / 10 towers	0	0,1	0,1	0	9,7	0	0	0,4

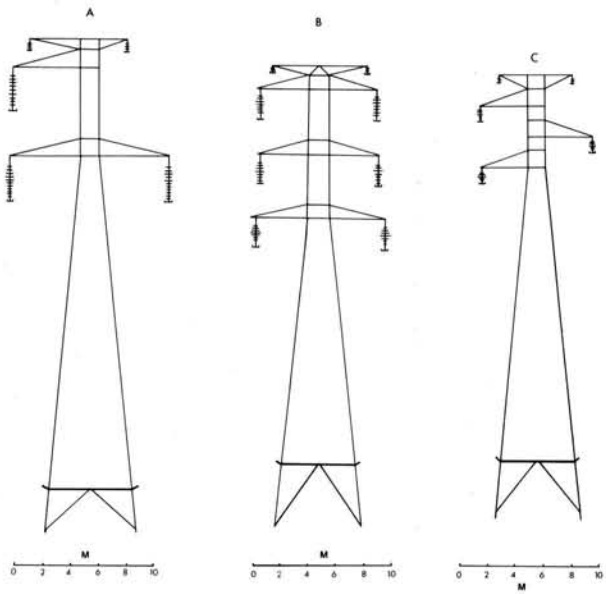

FIGURE 2: Electricity transmission towers surveyed in SWA/Namibia. A = 330 kV tower, B = 220 kV dual current tower and C = 220 kV tower.

types. Only one collision incident was recorded, a secretarybird *Sagittarius serpentarius* found freshly dead below the powerlines near Gibeon in Dwarf Shrub Savanna habitat.

Nests

Six species of raptors and three of passerines were found nesting on the 330 kV and 220 kV electricity towers (Table 3). Raptors bred at low densities on the towers with an overall linear inter-nest distance of 76 km. Nesting density was inversely related to rainfall (Figure 3) and was highest in the Dwarf Shrub Savanna in the south of the country. The blackbreasted snake eagle *Circaetus gallicus* was the most common raptor species nesting on electricity towers (n = 5) followed by pale chanting goshawks *Melierax canorus* and greater kestrels *Falco rupicoloides* (n = 3 each).

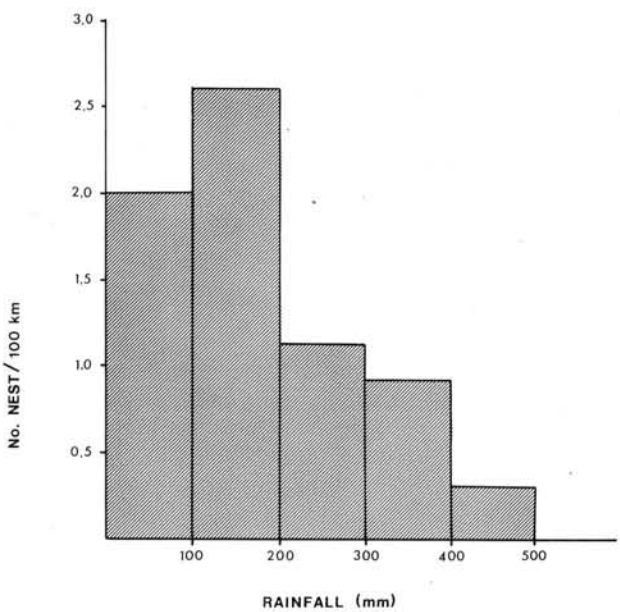

FIGURE 3: Number of raptor and crow nests per 100 km of transmission lines surveyed, plotted against rainfall.

There were few black crow *Corvus capensis* nests in towers, which was probably the reason for the low number of *Falco* species. Redbilled buffalo weavers *Bubalornis niger* were the most common birds found nesting in the towers. They were at highest densities in the Highland, Thornbush and Mopane Savanna regions and were uncommon in areas of less than 300 mm of rain per annum, except along large river courses. Sociable weaver *Philetairus socius* nests on towers were confined mainly to the southern Kalahari Savanna.

Black crows and pale chanting goshawks built nests only at low levels on the towers (position 6, Figure 4) and thus all but one nest occupied by *Falco* species were in this position (Table 4). The exception was a pair of lanner falcons *Falco biarmicus* occupying the nest of a large, unknown raptor at the top of the tower. The snake eagles nested in the main structure of the towers (as opposed to the side-arms supporting the conductors), mainly in the top struts (position 1) but also in the cross struts one level lower (position 3).

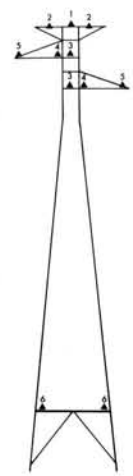

FIGURE 4: A general transmission support tower showing positions of nests and perched birds (see Tables 4 & 6).

All sociable weaver nests were built low on the corners of the towers around the anti-climbing wires (position 6) and 80% of redbilled buffalo weaver nests were in this position. Once the four corners of a tower had been occupied the buffalo weavers then occupied sites higher up the tower, either within the main structure (position 3) or at the junction of the side-arms and the main structure (position 4). Occupancy of sites at the ends of the side-arms and thus above the insulator and conductor (position 5) constituted only 2% of sites used by these birds and were used only once other sites were occupied. In addition, only in specific geographic localities were nesting densities so high as to result in buffalo weavers building nests in this position. These

TABLE 4: Position of nests on 330 kV and 220 kV electricity transmission support towers (see Figure 4) in SWA/Namibia.

Species	No. of nests in positions 1–6						
	1	2	3	4	5	6	Total
Brown Snake Eagles *Circaetus cinereus*	–	–	1	–	–	–	1
Blackbreasted Snake Eagle *Circaetus gallicus*	4	–	1	–	–	–	5
Pale Chanting Goshawk *Melierax canorus*	–	–	–	–	–	3	3
Lanner Falcon *Falco biarmicus*	–	1	–	–	–	1	2
Rock Kestrel *Falco tinnunculus*	–	–	–	–	–	2	2
Greater Kestrel *Falco rupicoloides*	–	–	–	–	–	3	3
Unidentified raptor nests	1	1	2	–	–	–	4
Black Crow *Corvus capensis*	–	–	–	–	–	11	11
Totals	5	2	4	0	0	20	31
Redbilled Buffalo Weaver *Bubalornis niger*	–	–	126	167	31	1 204	1 528
% Rb. B. W.	0	0	8	11	2	79	100
Sociable Weaver *Philetairus socius*	–	–	–	–	–	132	132

localities were where powerlines (i) ran near to or crossed large river courses and (ii) ran near the bases of large hills or mountain ranges, *i.e.* both sites more mesic than those surrounding.

Perching birds

Twelve species of birds, of rock kestrel size and larger, were found perching on the transmission towers (Table 5). Pale chanting goshawks were most common (48 % of all birds recorded) followed by blackbreasted snake eagles (22 %) and rock kestrels (13 %). Most birds (95 %) were perched on or in the top third of the towers while the remainder were at position 6 (see Figure 4). The top lattices (positions 1 & 2) were selected as perch sites by 60 % of the birds and the outer arms (positions 5) by 7 %, while 28 % of birds perched within the top third of the structure (positions 3 & 4) (Table 6). The use of these different perch sites depended on the species involved. Martial eagles, the snake eagles and pale chanting goshawks preferred the top struts of the towers whereas African hawk eagles and rock kestrels preferred perching within the structure.

Power failures

For the 330 kV lines lighting (44 %) and veld fires (29 %) were the main causes of disruption (Figure 5), and they were both highly seasonal (Figure 6). No disruptions were caused by birds. On the 220 kV lines lightning was the main cause of disruption (64 %) followed by bird pollution on insulators (17 %). Bird pollution was restricted to powerlines at two localities, the

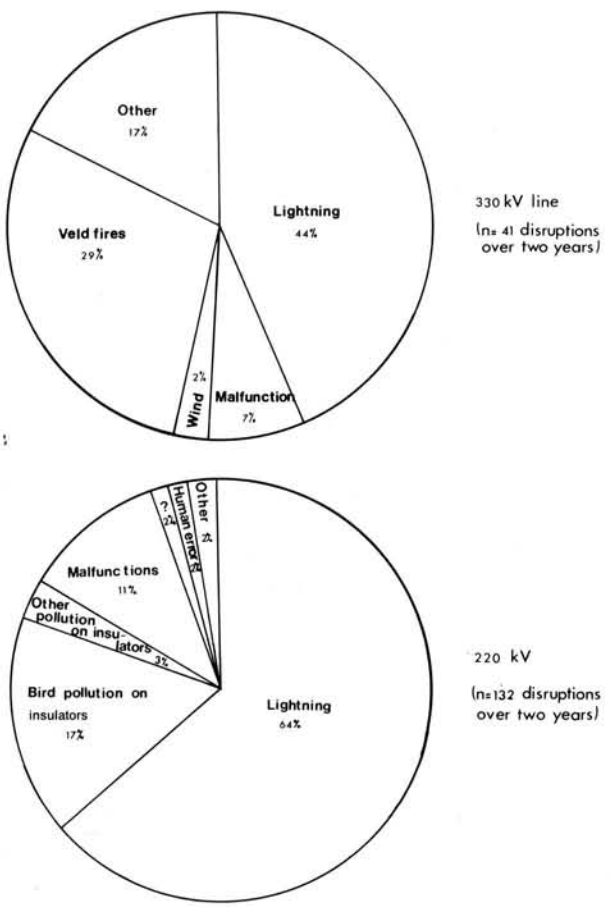

FIGURE 5: Causes of power disruption on the 330 kV and 220 kV line in SWA/Namibia during 1986 and 1987.

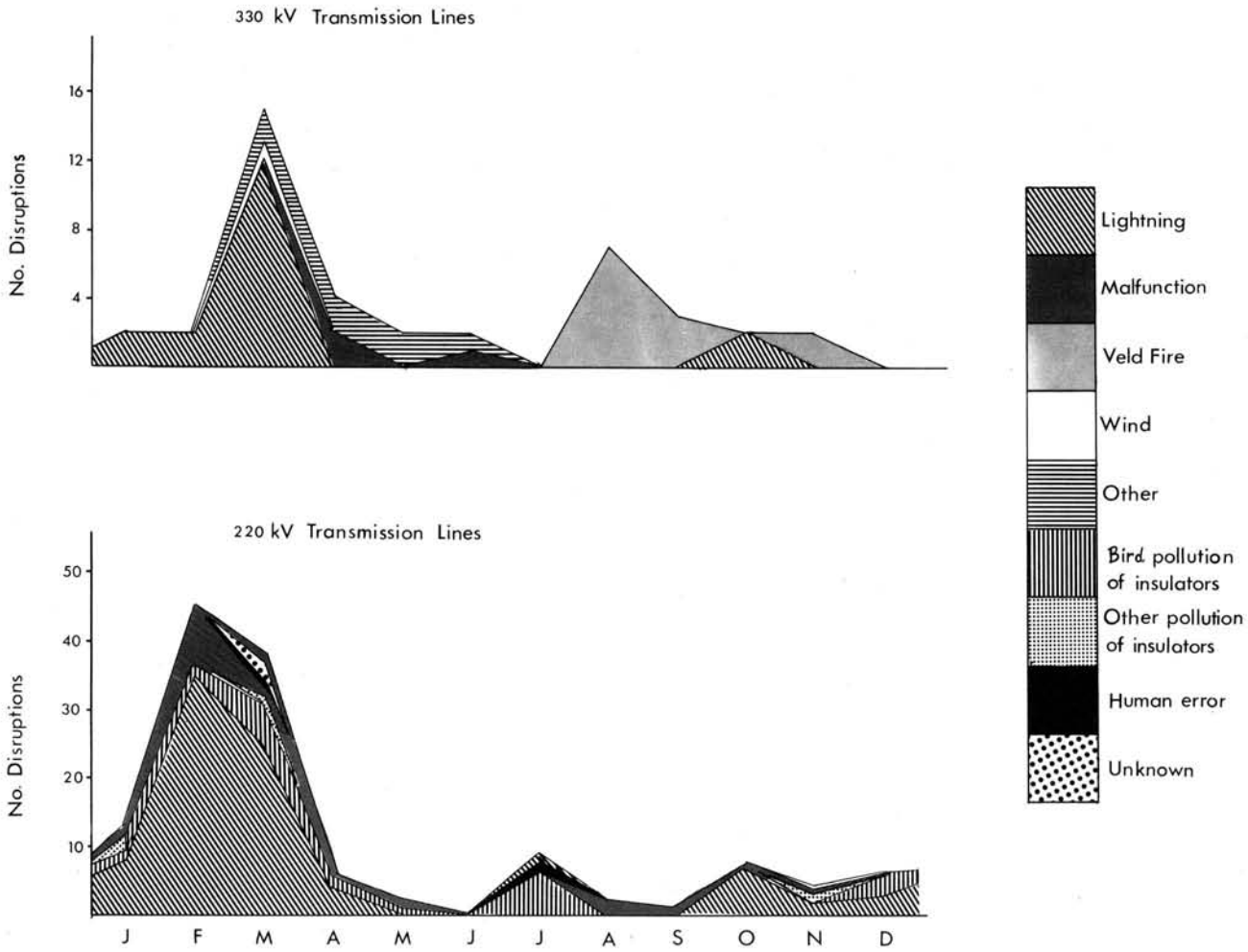

FIGURE 6: Seasonal incidents of power disruptions on the 330 kV and 220 kV lines in SWA/Namibia during 1986 and 1987.

Hardap Dam and the Goreangab Dam. The pollution was caused by the excreta of fish-eating birds. A subsequent check at Goreangab Dam found grey herons *Ardea cinerea* and reed cormorants *Phalacrocorax africanus* roosting on the pylons and local inhabitants reported that white pelicans *Pelecanus onocrotalus* and whitebreasted cormorans *Phalacrocorax carbo* also sometimes roosted there. No other power failures due to birds were reported. Other animals, a snake and a baboon, caused two power disruptions.

DISCUSSION AND RECOMMENDATIONS

Heijnis (1980) found that, in Holland, 70% of carcasses under transmission lines were scavenged within 24 h. This would indicate that counts such as those carried out in this survey in SWA/Namibia would provide absolute minimum figures. In the south of this country (region 5, where 40% of the survey was conducted), the numbers of scavenging animals have been drastically reduced by farmers using poisoned baits for mammalian predators (Brown 1986). Avian scavengers have been reduced to just 16% of their potential numbers based on a conservative estimate of available carrion (Brown 1988). While some carcasses might have been scavenged from under the transmission lines, this is unlikely to be as prevalent as in Heijnis' study. The incidence of electrocution and collision involving the 330 kV and 220 kV lines surveyed is therefore considered to be generally low. However, it should be borne in mind that not all collision victims die on impact, but may break wings and move away from the power lines. Also, the incidents of bird collision with powerlines may be seasonal (Longridge 1986), *e.g.* young flamingoes moving between their inland natal areas and the coast.

The nesting density of raptors on transmission towers was inversely proportional to rainfall, presumably because in low rainfall areas large trees available for birds to nest in are limited in number. However, the generally low density of raptors nesting on towers was surprising, particularly in the Dwarf Shrub Savanna region. In similar Karoo vegetation in the Cape Province, Boshoff (1986) found 12–13 pairs of martial eagles (18 nests) at a mean inter-pair distance of 23 km. This is a smaller inter-pair distance than for all raptor species combined in the Dwarf Shrub Savanna region of SWA/Nambia (38 km between nesting pairs), where no nesting martial eagles were found.

TABLE 5: Bird species of Rock Kestrel size and larger recorded perching on transmission towers during aerial surveys in seven vegetation types in SWA/Namibia (see Figure 1).

	Vegetation types							
	2	**5**	**6**	**7**	**8**	**10**	**11**	**Totals**
Transmission lines surveyed: Distance (km)	50	534	97	236	62	94	374	1 447
: No. towers	103	1 080	198	554	121	212	838	3 106
Species								
Tawny Eagle *Aquila rapax*	–	–	–	–	1	1	–	2
African Hawk Eagle *Hieraaetus fasciatus*	–	1	–	2	–	–	5	8
Martial Eagle *Polemaetus bellicosus*	–	2	–	1	2	1	–	6
Brown Snake Eagle *Circaetus cinereus*	–	–	–	1	–	1	4	6
Blackbreasted Snake Eagle *Circaetus gallicus*	2	21	2	17	1	4	14	61
Augur Buzzard *Buteo augur*	–	–	–	–	–	1	–	1
Blackshouldered Kite *Elanus caeruleus*	–	2	–	–	–	–	–	2
Pale Chanting Goshawk *Melierax canorus*	–	57	4	35	2	2	32	132
Lanner Falcon *Falco biarmicus*	–	9	–	–	1	–	–	10
Rednecked Falcon *Falco chicquera*	–	1	–	–	–	–	–	1
Rock Kestrel *Falco tinnunculus*	–	9	6	6	–	2	12	35
Greater Kestrel *Falco rupicoloides*	–	10	2	–	–	–	–	12
Totals	2	112	14	62	7	12	67	276
Total / 100 km	4,0	21,0	14,4	26,3	11,3	12,8	17,9	19,1

The habit of nesting on transmission towers may be a function of time; a bird raised in a tower nest may be more likely to choose such a site itself. However, the low number of nests found on these surveys would suggest that nests were being removed by the SWAWEC maintenance linemen. In the past, bird nests were known to cause "flashovers", particularly during rainy weather (P. Hoogenhout pers. comm. 1988). The species responsible was mainly the redbilled buffalo weaver. The nests of these birds, when situated near conductors, are therefore removed by the linemen. It is doubtful whether they are able to distinguish between the nests of these species and those of raptors and crows. The geographic localities where redbilled buffalo weavers build in the upper levels of towers (because the lower levels are already occupied by nests of conspecifics) are fairly specific; where powerlines pass near to large river courses and at the bases of hills. These localities could be mapped by the linemen and they could confine their nest-removing activities to these places. This would save on costs for SWAWEC and leave the other bird species, which cause few or no problems, undisturbed.

During 1986 and 1987 the only cause of power disruption due to birds was pollution by their excreta on conductors on towers near large water bodies. Since then, perch guards have been fitted above the conductors to prevent birds perching and roosting in these positions (P. Hoogenhout pers. comm. 1988). The effectiveness of this measure is still being evaluated.

Because the continual removal of raptor and crow nests from transmission towers is costly, time consuming, destructive to the birds and unnecessary, the following recommendations are offered, based largely on the findings of Olendorff *et al.* (1981) & Ledger (1983, 1988).

1. If nests are removed, the birds will usually rebuild. The chances of sticks being dropped and causing "flashovers" will thus be increased. Whenever possi-

TABLE 6: Site selection by birds perching on electricity transmission towers in SWA/Namibia. "Top" = positions 1 & 2, "side arms" = positions 5, "within" = positions 3 & 4 and "low" = positions 6; Figure 4.

Species	No. and % of birds perching in the various positions								
	Top		Side arms		Within		Low		Totals
	No.	%	No.	%	No.	%	No.	%	
Tawny Eagle *Aquila rapax*	1	50	–	–	1	50	–	–	2
African Hawk Eagle *Hieraaetus fasciatus*	1	12	–	–	7	88	–	–	8
Martial Eagle *Polemaetus bellicosus*	5	83	–	–	1	17	–	–	6
Brown Snake Eagle *Circaetus cinereus*	6	100	–	–	–	–	–	–	6
Blackbreasted Snake Eagle *Circaetus gallicus*	46	75	4	7	7	11	4	7	61
Augus Buzzard *Buteo augur*	1	100	–	–	–	–	–	–	1
Blackshouldered Kite *Elanus caeruleus*	–	–	–	–	2	100	–	–	2
Pale Chanting Goshawk *Melierax canorus*	88	67	6	5	33	25	5	4	132
Lanner Falcon *Falco biarmicus*	2	20	7	70	1	10	–	–	10
Rednecked Falcon *Falco chicquera*	–	–	1	100	–	–	–	–	1
Rock Kestrel *Falco tinnunculus*	12	34	–	–	20	57	3	9	35
Greater Kestrel *Falco rupicoloides*	4	33	1	8	4	33	3	25	12
Totals	166	60	19	7	76	28	15	5	276

ble, therefore, nests should be left in place and undisturbed.

2. The nests of raptors nesting directly above insulators should be left in place until the end of the breeding season. Raptors produce little excreta compared with fish-eating birds and they are unlikely to seriously pollute the insulators in one season. At the end of the breeding season (once the young bird has left the nest) the nest should be carefully moved a minimum distance to an acceptable site on the tower.

3. Sticks hanging down below nests towards conductors should be trimmed without disturbing the main nest structure.

4. Nests containing eggs or young chicks should not be disturbed. In particular, parent birds should not be kept off nests in cold or hot weather as their offspring may chill or overheat and then die.

It is suggested that these recommendations should be made SWAWEC company policy, and all linemen should be made familiar with them.

These recommendations will not only improve transmission line reliability and reduce operating costs, but will also be of benefit to the birds nesting on the towers, thereby enhancing the conservation immage and credibility of SWAWEC in the public mind.

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