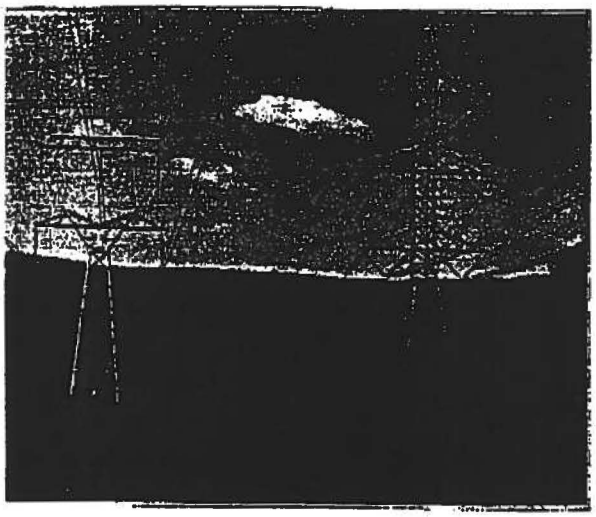
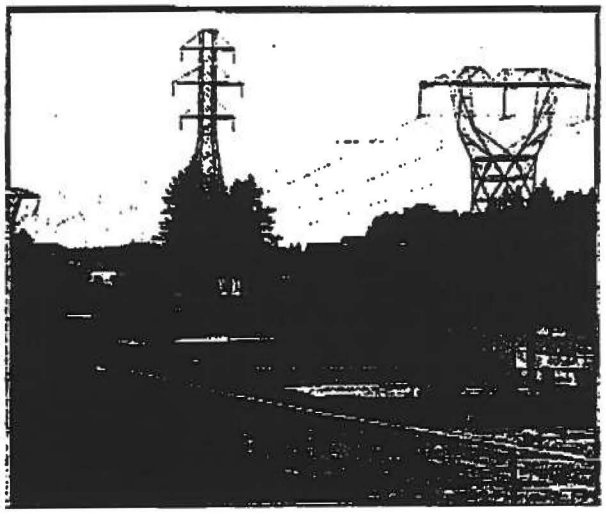
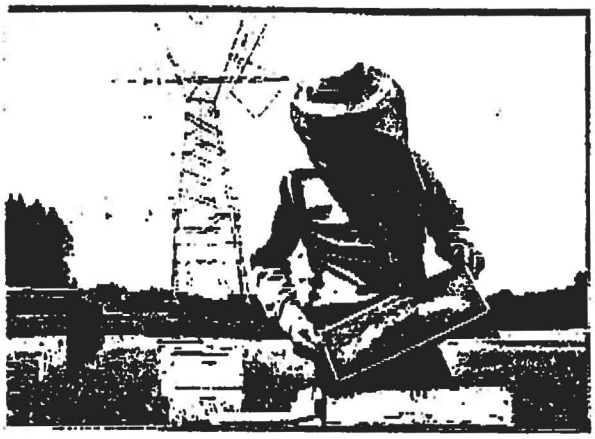
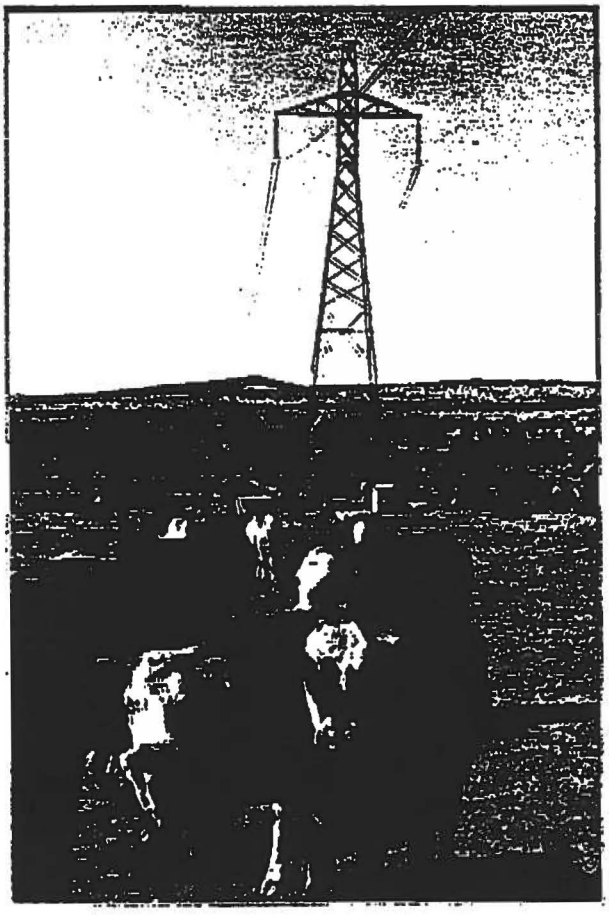
Electrical and Biological Effects of Transmission Lines

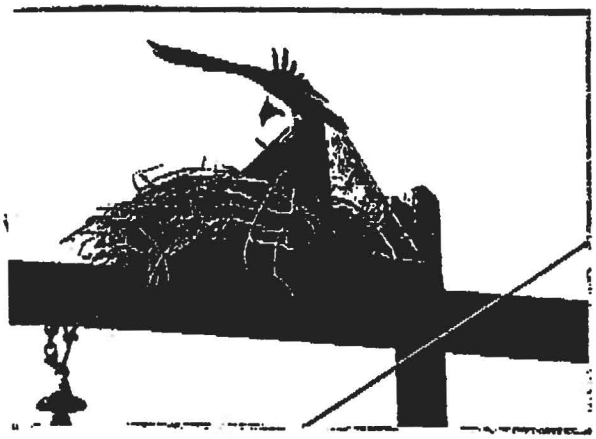
A Review











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ELECTRICAL AND BIOLOGICAL EFFECTS OF TRANSMISSION LINES: A REVIEW

Prepared by the Biological Studies Task Team

Jack M. Lee, Jr.
Vernon L. Chartier
David P. Hartmann
Gerald E. Lee
Katherine S. Pierce
Fay L. Shon
Rick D. Stearns
Michael T. Zeckmeister

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Wildlife

This section addresses the possible effects of electric and magnetic fields on wild birds, mammals, and fish. Almost all the research involving wildlife has consisted of studies of transmission lines in natural environments. Emphasis in most of the studies involving powerlines was on the effects of the right-of-way, and only rarely was specific attention given to possible field effects (see papers in Arner and Tillman 1981, and Crabtree 1984). However, this research does suggest that, compared to effects of construction and maintenance, any effects of electric and magnetic fields on wildlife are subtle and difficult to identify (Lee et al. 1979).

In the typical situation where mammals or birds are within or beneath vegetation, that vegetation largely shields them from a transmission line electric field. When mammals such as deer and elk move through areas of low-growing vegetation, they may be subject to induced body currents, shocks, and perception effects. Because the larger animals are normally grounded to a degree through their feet, it is unlikely that they experience shocks in these fields. It is possible that some wildlife species are able to detect weak induced currents. Based on studies with laboratory animals, wildlife may be able to detect electric fields through such means as hair or feather stimulation (e.g., Cooper and Graves 1981, Stern and Laties 1982). Research to date, however, has not shown that these fields adversely affect wildlife behavior or health.

Mammals. Goodwin (1975) observed no apparent effects of the electric or magnetic field of a 500-kV line in Idaho on movement of deer and elk. Some animals were attracted to the cleared right-of-way for feeding. However, during the hunting season, game animals tended to avoid the right-of-way and other similar clearings during daylight.

Schreiber et al. (1976) examined the effects on small mammals of a right-of-way in Tennessee containing two 500-kV lines. In hardwood forests, small mammals were more abundant on the cleared right-of-way than in the adjacent forest. In pine forests, the reverse occurred. In both areas, the right-of-way was used by some species not present in the adjacent forest. Use of the various areas by small mammals appeared to be strongly influenced by vegetation composition and distribution, which affects cover and food availability.

Small mammals were studied for several years as part of a research program for the BPA 1200-kV prototype (Rogers et al. 1980, Warren et al. 1981). No adverse electric field effects on mammals were found. Animals were most abundant on the right-of-way and in the nearby control areas during the first 2 years of construction and operation. Mammal abundance on the right-of-way and control areas declined in subsequent years. After initial right-of-way clearing, tall brush had become re-established on the right-of-way, thus shielding small mammals from the electric field.

Birds. Studies of song birds near transmission lines also indicate that vegetation on the right-of-way, rather than electric or magnetic fields, is the primary factor influencing usage and behavior (e.g., Rogers et al. 1980, Anderson et al. 1977, Kroodsma 1984). For birds, however, some additional considerations arise.

Where transmission lines cross open country, some birds such as hawks and eagles often use the towers for perching and nesting (Howard and Gore 1980). Although there are some shielding effects from tower parts, birds nesting on these structures can be exposed to electric fields for long periods. Birds nesting on BPA lines have been studied to determine whether there are harmful effects from the energized line. A sample of hawks nesting on 500-kV and 230-kV line towers produced about the same average number of young as were reported for hawks nesting in trees and cliffs (Lee 1980) (Figure 17).

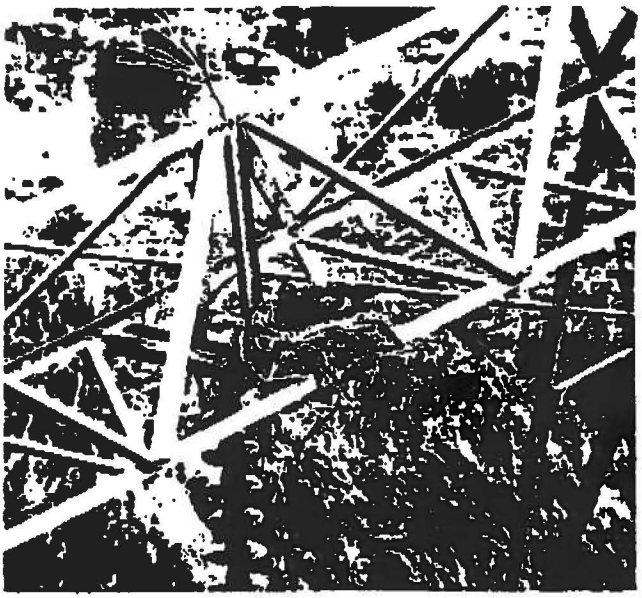

FIGURE 17. *Hawks nesting on BPA 500-kV transmission towers produce about the same average number of young as hawks nesting on trees and cliffs.*

Large birds such as eagles can be electrocuted if they contact a conductor and grounded hardware, or if they contact two conductors (different phases). These problems are generally associated with distribution lines of 12 kV to 69 kV (Olendorff et al. 1981). Transmission line conductors are usually far enough away from other conductors or hardware so that bird electrocutions seldom occur. Special line designs have been developed for protecting raptors and other birds from power-line electrocutions. These are described in a report distributed by the Raptor Research Foundation (Olendorff et al. 1981).

Some studies have produced evidence indicating that birds can perceive a-c magnetic fields at strengths comparable in magnitude to those of the earth's d-c fields (e.g., Larkin and Sutherland 1977). Whether such fields disrupt avian flight orientation, provide environmental location information to flying birds, or have no effect at all is not clear. During migration, birds must routinely fly over probably hundreds (or thousands) of electrical transmission and distribution lines. We are not aware of any evidence to suggest that such lines are disrupting migratory flights.

Research on bird collisions with BPA transmission lines does not suggest that transmission line magnetic and/or electric fields cause noticeable disorientation in flying birds. Most waterfowl and other birds during low altitude flight typically react to the presence of transmission lines by altering flight direction or altitude to avoid colliding with the lines (Lee 1978, Meyer and Lee 1981, Beaulaurier et al. 1984).

Fish. Some fish are known to be sensitive to very weak, low-frequency electric and magnetic fields in water. Sharks and some other species have special organs (ampullae of Lorenzini) for detecting biofields from other fish and probably the earth's fields (Kalmijn 1966). For example, skates were shown to respond to 5-Hz square wave fields of only 0.001 mV/m, and stingrays oriented to uniform electric fields as small as 500 nanovolts/m (1 nanovolt = one-billionth of a volt) (Kalmijn 1982).

American eels and Atlantic salmon reportedly can also perceive low frequency electric fields of 7 to 70 mV/m (McCleave et al. 1974). However, 45 to 75-Hz electric fields up to 20 V/m had little, if any, effect on behavior of bluegill fry (McCleave et al. 1974, Coate et al. 1970).

A 10 kV/m transmission line electric field in air would produce a field in water of around 1 mV/m (Miller and Kaufman 1978). This field tends to be even less because conductor clearances are often higher than minimum over navigable waters. Also, streams and rivers are often in a narrow topographical depression and thus partially shielded. In this last situation, support towers may be located at higher elevations, resulting in large conductor clearances over the water.

Livestock

Utility operating experience and results of research generally show that transmission line electric fields do not affect livestock behavior or health (Lee and Reiner 1983). Livestock of all types can often be seen feeding or resting beneath transmission lines.

Occasionally utilities receive reports that a transmission line was related to some livestock illness or death. Typically, when these reports are investigated, or when livestock owners are surveyed, no evidence is found to substantiate such reports (Ware 1974, Busby et al. 1974).

A comprehensive study of livestock living near a 765-kV line in Indiana was sponsored by American Electric Power Service Corporation (Figure 18). Included in the study were beef and dairy cattle, sheep, hogs, and horses on 11 farms. Farmers were interviewed bi-monthly and periodic inspections were made by a veterinarian. The 765-kV line produced electric fields on some of the farms of up to 12 kV/m. The study found no evidence that health, behavior, or performance of livestock were affected by electric fields (Amstutz and Miller 1980).

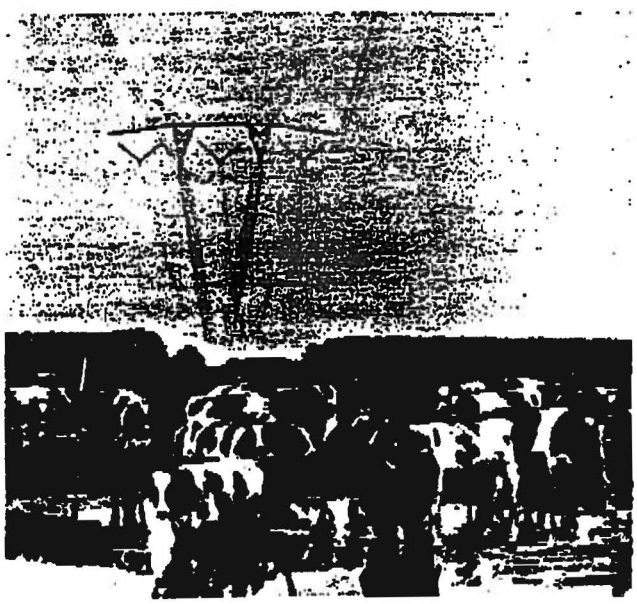

FIGURE 18. *Studies in the Midwest have found no effects of electric fields on dairy cattle and other livestock.*

A 6-year-long study in Ohio investigated 55 dairy farms located near 765-kV lines (Williams and Beiler 1979). There was no indication that the presence of the lines had any long-term effects on milk production. After the lines had been constructed, the incidence of calf mortality and birth defects ***per farm*** increased. The researchers believed this may have been a reflection of a trend for larger herd sizes per farm during the study period. The dairymen interviewed during the study believed there was no evident change in health problems after the lines were energized.

Research in Sweden involved cattle near 400-kV lines. Studies were prompted because of reports that cattle fertility decreased on two farms following energization of 400-kV lines (Algers et al. 1981). In pilot studies involving 36 herds near 400-kV lines and where artificial insemination was used, no effects on cattle fertility were found compared to a control group. A larger study was conducted that involved 106 farms throughout Sweden (Hennichs 1982). The study, conducted primarily by mail survey,