UTILITY POLE USE AND ELECTROCUTIONS OF RAPTORS AT BEALE AIR FORCE BASE, CALIFORNIA

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ABSTRACT: We determined the risk of raptor electrocution at Beale Air Force Base by assessing the frequency of use and fatalities on high-risk power line pole types (HRP types) suspected of causing raptor electrocutions. From January to April 2000, we recorded raptor use on 9 individual roadside surveys, and recorded raptor fatalities on 3 separate foot surveys. We surveyed a total of 495 HRPs consisting of 28 different HRP types. We observed 58 perching occurrences, and recorded use for only 7 HRP type categories. Raptor use on 4 combined HRP categories was disproportionate to the availability of HRP types. In addition, 86% of raptor use was recorded on 3 of the 7 HRP types suggesting preference for particular HRP types. We found 2 dead raptors of unknown species during the study under the same HRP. Three of the 58 raptor uses recorded occurred on this HRP.

Key words: California, Beale Air Force Base, electrocution, fatalities, perching, raptor, utility pole

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Raptors are exposed to electrocution risk from powerlines because many designs of power-line poles place conductors and groundwires close enough together so that the raptors can touch them simultaneously with their wings or other body parts (APLIC 1996). Raptors apparently are attracted to power-line poles because they provide elevated sites that permit a wide radius of vision for hunting and easy takeoff (Boeker and Nickerson 1975). In addition, in areas where natural perches such as trees and cliffs are limited, raptors use power-line poles as nest sites (Boeker and Nickerson 1975, APLIC 1996).

Two design factors determine the relative safety of electrical power lines for raptors: (1) distance between phase conductors relative to the wing spans of birds, and (2) distance between grounded hardware (i.e., groundwires or metal braces) and energized conductors (i.e., phases) relative to wing span or to the distance from the tip of the bill to the tip of the tail (APLIC 1996). A bird may be electrocuted when it contacts 2 energized phases at the same time, or when it simultaneously contacts grounded hardware and an energized conductor. The likelihood of spanning conductors with outstretched wings or other body parts is much greater for large birds (APLIC 1996, Thelander 1999).

Several raptor protection measures have been incorporated into the permitting and licensing requirements placed upon the utility industry for new transmission projects (APLIC 1996). Suggested practices include, but are not limited to, constructing elevated perches, following minimum spacing standards between phases and between phases and groundwires, excluding metal crossarm braces, and covering groundwire with insulating material to prevent simultaneous phase-to-ground contact (APLIC 1996).

The first step in preventing raptor electrocutions is to identify problem areas, usually through collection and analysis of bird fatality data (APLIC 1996). Studies investigating bird fatalities near electrical facilities are essential for determining actions needed to reduce future electrocutions. In addition, identifying poles that present the greatest risk of electrocution would help prioritize management actions (APLIC 1996). By ordering the poles by their associated electrocution risk, a determination can be made as to which poles raptor protection measures should be applied to first.

Raptor fatalities have been reported at Beale Air Force Base, Yuba County, California as a result of raptor encounters with power-line poles (K. Christopherson, Natural Resources Manager, Beale Air Force Base, personal communication). Certain power-line pole designs are known to increase the risk of electrocuting raptors (APLIC 1996); these power-line pole types were referred to as "high risk" power-line pole types (HRP types) in our study. Our goal was to determine the risk of raptor electrocution at Beale Air Force Base to determine whether management actions are needed to reduce future electrocutions. To fulfill this goal, our objectives were to: (1) assess the risk of raptor electrocutions at Beale Air Force Base by quantifying raptor use of HRPs and the frequency of raptor electrocutions, (2) identify which HRP types present the greatest risk of raptor electrocution by quantifying raptor use of specific HRP types and the frequency of raptor electrocutions associated with specific HRP types, and (3) use this information to prioritize management actions.

STUDY AREA

We conducted our study at Beale Air Force Base, Yuba County, California, located approximately 80 km north of Sacramento, California. Beale Air Force Base comprises approximately 9,285 ha of which approximately 80% (app. 7,428 ha) is currently undeveloped. Vegetation types present include annual grasslands, oak (*Quercus* ssp.) woodlands, orchards and eucalyptus (*Eucalyptus* ssp.) stands, riparian wetlands, open water and perennial drainages, other seasonal wetlands, disturbed seasonal wetlands, permanent marsh, seasonal swales, and vernal pools. Annual grassland is the predominant vegetation type, much of which supports cattle grazing from May through November each year. Approximately 3,000 power-line poles are currently located on Beale Air Force Base (L. Kinkor, Electrical Engineer, Beale Air Force Base, personal communication).

METHODS

Following survey methods similar to those used in previous raptor use and raptor electrocution studies (e.g., Stahlecker 1978, Ferrer et al. 1991, Thelander 1999), we established 17 survey routes and defined the HRPs to be included in the surveys. We established the survey routes by first identifying strings of power poles that could be viewed from the road on Beale Air Force Base. An estimate of the total number of HRPs visible from the road was made along with an estimate of the number representing each HRP type. We selected strings of power poles so that the survey routes would be representative of the proportions of HRP types present within view of the roads. A random number table was then used to determine starting points within these strings. We surveyed the same poles within each route during each sampling effort.

We surveyed 495 HRPs consisting of 28 different HRP types for raptor use and fatalities. We divided the HRP types into 18 categories based on the spacing of energized conductors and the presence of additional wires, jumper wires, switches, and transformers (Thelander 1999). We designated HRP type categories with common conductor spacing and lacking additional wires, jumper wires, switches, and transformers with a single letter of the alphabet. We referred to the categories lacking additional wires, jumper wires, switches, and transformers as simple base designs. We designated HRP type categories sharing the common conductor spacing of a simple base design and including additional wires, jumper wires, switches, and transformers by placing the word Complex in front of the single letter of the alphabet representing the shared simple base design. We referred to the categories including additional wires, jumper wires, switches, and transformers as complex designs. Following these methods, the designation and sample sizes of the HRP type categories were: A, 116; Complex A, 90; B, 26; Complex B, 40; C, 74; Complex C, 33; D, 2; F, 16; Complex F, 5; G, 7; Complex G, 3; K, 16; Complex K, 6; L, 7; Complex L, 9; M, 30; Complex M, 1; and Complex N, 14.

We included only distribution lines in the survey routes because they have been reported to be utilized at a greater rate by raptors, and have been associated with a greater number of raptor fatalities relative to transmission lines (APLIC 1996, Thelander 1999). Transmission line conductors are generally spaced 2.1 to 9.1 m apart and have been associated with raptor electrocutions only in isolated cases (APLIC 1996). We sampled for raptor use of HRP's on each of the survey routes on 9 occasions between January and April 2000. Because the same poles were repeatedly sampled on 9 occasions, all of the observations were not completely independent.

We conducted roadside surveys to collect data on raptor use of HRPs. During surveys, we collected data on raptor use of HRPs by recording the number and type of each species perched on a HRP and the type of HRP. In addition, we recorded the date, survey route, designated pole number, and predominant habitat type within 200 m of the pole. To avoid disturbing any raptors perched on the HRPs before they could be observed, we used binoculars to identify perched birds from a distance (Stahlecker 1978). Surveys of raptor use began around 08:30 and ended around 14:30.

We quantified raptor use by calculating the overall frequency of raptor perching (number of raptors per HRP) (Thelander1999). We also quantified raptor use of specific HRP types by calculating the overall frequency of raptor perching on HRP type categories (number of raptors per HRP type category). To determine if raptor use was independent of HRP type, we used the frequency of raptor perches on four HRP type categories (A, Complex A, B, and combined categories Complex C, D, Complex B, and C) to conduct a chi-square test of independence resulting in a 2x4 contingency table (Zar 1984).

We sampled for raptor fatalities on 3 occasions at 1-month intervals by walking along the power distribution lines included in roadside survey routes. We recorded the number and type of species found beneath a HRP and the HRP type. We also recorded the date, survey route, designated pole number, and predominant vegetation type within 200 m of the power pole. Raptors exhibiting evidence of burns on the primaries, talons, or beak were considered electrocuted (Thelander 1999). Surveys for raptor fatalities began around 08:30 and ended around 17:30.

We quantified raptor fatalities by calculating the overall frequency of raptor electrocutions (number of fatalities per HRP) (Thelander 1999). We also quantified raptor electrocutions on specific HRP types by calculating the frequency of raptor electrocutions on specific HRP type categories (number of raptors electrocuted per HRP type category).

RESULTS

We observed 58 perching occurrences involving 7 HRP type categories (Table 1). We recorded no raptor perching occurrences for the other 11 HRP type categories. We observed 3 species of raptors perching on HRPs; red-tailed hawks (*Buteo jamaicensis*), American kestrels (*Falco sparverius*), and a northern harrier (*Circus cyaneus*). We found that 86% of the 58 observed perching occurrences were on 3 of the 7 HRP type categories (Table 2). Frequency of raptor use was significantly associated with the 4 combined HRP categories ($x^2 = 26.221$, $P < 0.0001$, $df = 3$). Thus, raptor use on the 4 categories appears to be disproportionate to availability. The difference appears to be due to the relative lack of raptor use of the combined category (Complex B, C, Complex C and D) relative to the availability of those HRP type categories. Even though the combined category represented 39% of the available HRPs, only 8% of the observed raptor use occurred on these HRPs. There also appears to be a trend towards greater use of HRP type category B relative to availability.

We found 2 dead raptors, both under the same HRP, which was representative of HRP type category Complex A. We recorded 3 of the 58 recorded raptor uses on this specific HRP. We could not identify the species of raptor electrocuted due to the condition of the corpses.

DISCUSSION

Our results suggest that raptors exhibit preferential use of certain HRP types. Variations in the amount of development around different HRPs, prey availability, and other factors might have contributed to the differences observed in use of HRP type categories. The vegetation adjacent to all of the HRPs surveyed was similar and consisted of grassland and intermittent oak woodland. Additional studies examining raptor use on different HRP types should determine the effect of development, prey availability, and other variables on use of HRPs.

The raptor corpses found during our study were within the size of hawks and large owls. Other authors have reported that a majority of raptor electrocutions involve eagles, hawks, and owls (O'Neil 1988, Ferrer et al. 1991, APLIC 1996 and Harness and Wilson 2001). In addition, the HRP responsible for the 2 raptor electrocutions observed is representative of a complex design and includes two transformers. Other authors have also reported that a majority of their observed raptor fatalities involved complex designs with transformers (APLIC 1996 and Harness and Wilson 2001).

Although raptor fatalities do not appear to be a significant problem at Beale Air Force Base, the number of fatalities observed was probably underestimated because we did not conduct a study to determine the rate at which

Table 2. Percent raptor use observed on each high risk power-line pole type at Beale Air Force Base, Yuba County, California, 2000.

HRP type	Raptor Use (%)	No. Pole (%)
Complex A	26	90 (24)
A	21	116 (30)
Complex B + C + Complex C + D	8	149 (39)
B	14	26 (7)

Table 1. Raptor perching frequencies for 3 raptor species on 7 different high risk power-line pole types at Beale Air Force Base, Yuba County, California, 2000.

Species	Complex A	A	Complex E	D	Complex F	C	B	Total
Red-tailed Hawk	8	6	1	1	1	1	4	22
Northern Harrier	0	1	0	0	0	0	0	1
American Kestrel	7	14	0	0	2	2	10	35
Total	15	21	1	1	3	3	14	58

corpses are carried away by scavengers and predators. Ferrer et al. (1991) reported that during 1-month census intervals, 37% percent of carcasses were not removed by scavengers. In addition to scavengers, underestimation of fatalities might have resulted due to electrocuted birds not dying instantly.

Because our study was conducted for a single season, continued monitoring for raptor fatalities on HRP types is warranted. When fatalities are recorded, implementation of appropriate protection measures should be considered. Given that the known fatalities are concentrated in a single location, appropriate protection measures could be implemented to prevent future electrocutions.

Future studies could address why raptors landing on HRP types known for electrocuting raptors are not being electrocuted. It is possible that the observed frequency of raptor use was not high enough during our study to demonstrate the HRPs' capability for electrocuting raptors.

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