Wildlife Damage in Electric Substations in New York

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ABSTRACT

Wildlife managers have long been concerned with the damage wildlife can cause, especially to agricultural crops. However, one area which has received little research is the damage caused by wildlife to electric substations. Such research is needed because damage to electric substations increases operating costs of utilities and reduces reliability of service to customers.

Six member utilities of the Empire State Electric Energy Research Corporation (ESEERCO) were surveyed to identify classes of substations experiencing animal-caused faults (i.e., short circuits), and to determine the impacts of those faults. Records of more than 200 animal-caused faults occurring from 1970-88 were examined. The mean cost of each fault was $12,550, and the total cost incurred by New York state utilities from 1970-88 may have been as high as $10 million. Substations experiencing animal-caused faults tended to be older (>30 yrs), taller-profile structures of mid-range distribution-voltage classification. Sixteen types of animals caused faults in substations. However, squirrels (55%), birds (16%), and raccoons (12%) accounted for 83% of the faults. Although all electrified substation equipment was susceptible to faults, only 4 types of equipment experienced 74% of the faults. These findings provide information useful for targeting individual substations and specific substation equipment for protection from animals. Wildlife managers and damage control specialists may find this information useful as utilities search for ways to stop "preventable" animal-caused faults.

INTRODUCTION

Researchers have long studied wildlife damage to agricultural crops such as hay and corn (e.g., McDowell and Pillsbury 1959, Flyger and Thoerig 1962, Sperow 1985) and fruit crops (e.g., Decker and Brown 1982). The damage caused to highways and timber products as a result of flooding by beavers also has been researched (Purdy et al. 1985; Enck et al. 1988). In recent years, additional management concerns have arisen such as deer-car collisions (e.g., Wood and Wolfe 1988) and wildlife damage to ornamental plantings (e.g., Conover and Kania 1988). All of these areas of interest are receiving increasing research attention as the various stakeholder groups express their concerns to wildlife managers. However, one type of animal damage that has received relatively little attention is damage caused by wildlife to electric substations.

Damage to a utility's electric system resulting from electric faults increases operating costs for the utility and decreases the reliabilty of service provided to customers. Faults caused by animals are of special concern because those faults generally are considered to be preventable, unlike lightening strikes or accidents. Animals may cause faults to transmission and distribution lines or to substation equipment. Although faults in substations are less numerous than faults to transmission and

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distribution lines, they may be more costly because of the types of equipment and greater numbers of customers affected. Few types of wildlife damage have as great a potential for impacting so many persons per incident as animal-caused faults in electric substations. However, animal-caused faults in substations previously have not been examined on a statewide basis.

This study was undertaken because some of the electric utilities in the Empire State Electric Energy Research Corporation (ESEERCO) in New York perceived an increase in the frequency of animal-caused faults in their distribution class substations. The purpose of the study was to identify the scope of animal-caused faults in electric substations in New York, determine the animal species involved, estimate the cost of restoring service, and estimate the value of revenue lost to the utilities resulting from loss of service to customers.

METHODS

Six member utilities of ESEERCO chose to participate: Central Hudson Gas & Electric Corporation, Consolidated Edison Company of New York, New York State Electric & Gas Corporation, Niagara Mohawk Power Corporation, Orange and Rockland Utilities, and Rochester Gas and Electric Corporation. Contact persons were established at each of the participating utilities. They were asked to provide information about all animal-caused faults which occurred from 1970-88 for which they had records. To assist them in this task, data forms were developed that contained questions pertaining to 4 types of information: (1) general information about the faults such as the date and time of each fault and the species of animal causing the fault, (2) information about the damage that resulted from the fault, (3) site information characterizing the habitat in and around the substation, and (4) information on the costs incurred as a result of the fault. Personal visits were made to the utilities to assist in data collection and to examine substations which had experienced animal-caused faults as well as those which had not.

RESULTS AND DISCUSSION

Records were available for 206 animal-caused faults occurring in 128 substations from 1970-88. However, the number of years the 6 participating utilities maintained records varied from 4 to 18. Thus, 206 represents a minimum number of animal-caused faults over the time period of interest.

Reported animal-caused faults represented 10-15% of all faults recorded in electric substations, but the actual percentage of faults caused by animals may have been much higher. Utility contact persons believed that the cause of many animal-caused faults were reported as unknown because no evidence of the animal causing the fault was found at the time of the investigation. In addition, interviews with utility personnel who were knowledgeable of specific animal-caused faults indicated that records of some of those faults did not exist.

Of the electrical faults for which records did exist, some kinds of animals were more likely to cause faults in substations than were others. Sixteen types of animals caused faults in electric substations although 3 types of animals caused more than three-quarters of all animal-caused faults (Table 1). Of the 206 faults recorded, over half (55%) were caused by gray squirrels [*Sciurus carolinensis*], 1 in 6 were caused by a bird, and 1 in 8 were caused by a raccoon [*Procyon lotor*].

Table 1. Types of animals known to have caused faults in electric substations in New York State, 1970-88.

Animal	Number of incidents	Percent of incidents
Gray squirrel	113	55
Raccoon	25	12
Bird	33	16
Unidentified bird	(27)	
Great-horned owl	(1)	
American crow	(2)	
Rock dove	(3)	
Small mammals	14	6
Mouse	(9)	
Norway rat	(2)	
Unidentified rodent	(3)	
Larger mammals	3	2
House cat	(1)	
Red fox	(1)	
Virginia oppossum	(1)	
Other animals	18	9
Unidentified snake	(1)	
Bird nest material	(8)	
Termites	(1)	
Unidentified animal	(8)	
	206	100

Most faults occurred at the time of day or season of the year when the animals were most active. About 70% of the faults occurred from 0400-1200 hr. Also, about 80% were recorded from April through October corresponding to the time of annual increase in animal populations as well as the time of year when many types of animals are likely to enter substations in search of nest sites or food.

After entering a substation, climbing or perching animals potentially could fault any type of electrified equipment (Figure 1). However, 74% of all faults occurred to only 4 types of equipment: buswork, circuit breakers, transformers, and capacitors (Table 2).

Animals tended to cause faults to these types of equipment in specific ways. Most buswork faults were caused when an animal simultaneously contacted the electrified bus and a grounded bus support post at an insulator. Circuit breaker and transformer faults were caused mostly when an animal perched or climbed around the bushings. Faults to capacitors were caused when an animal contacted 2 or more electrified cables or a cable and a ground.

Although all distribution substations contained buswork, circuit breakers,

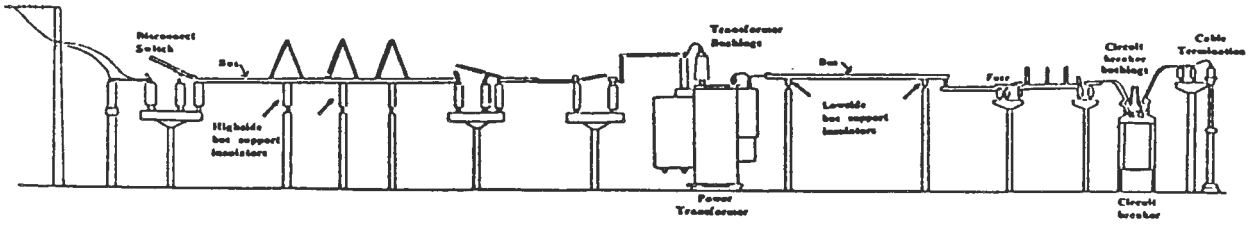

Figure 1. Simplified schematic of a substation showing some of the equipment most commonly experiencing animal-caused faults.

Table 2. Types of equipment on which animals caused faults in electric substations in New York from 1970-88.

Substation equipment	Number of incidents	Percent of incidents
Buswork[1]	76	37
Circuit breaker[2]	32	16
Transformer[3]	22	11
Capacitor	20	10
Disconnect switch/fuse	13	6
Cable terminator[4]	7	3
Regulator	5	2
Cable	4	2
Unidentified equipment	27	13
	206	100

[1]Includes insulators and conductors

[2]Includes circuit reclosers

[3]Includes power and potential transformers

[4]Includes potheads and risers

transformers, and ususally capacitors, the design and age of the equipment differed greatly among substations. Most (81%) animal-caused faults occurred in substations which had a high physical profile[2]. More than one-third (35%) of the animal-caused faults occurred in substations that had been operating for 16-30 yrs whereas only 10% of the faults occurred in newer substations. About one-quarter (28%) of the animal-caused faults occurred in substations which had been operating 31-45 yrs and about one-quarter (27%) in substations which had been operating for >45 yrs. Information was not available on the statwide distribution of substations within each age category. However, utility contact persons indicated that the most susceptable substations were those which had a high profile and had been operating for 16-30 yrs whereas the least susceptable substations were newer substations which tended to have a low profile with less overhead structure and thus less opportunity for animals to perch or climb on the equipment and cause faults.

Susceptability also was related to the voltage classification[3] of the substations. Most animal-caused faults occurred in 15 kV (55%) and 5 kV (39%) class substations.

[2]Substation profile was recorded as either high or low. High profile referred to those substations with latticework or other support structures above the substation equipment and usually exceeding about 8 m in height.

[3]Electricity enters distribution substations under high voltage, is reduced through 1 or more transformers, and exits the substation at a lower voltage. The substation is classified by the voltage of the electricity leaving the substation.

According to utility records, 15 kV class substations represented about one-third of all distribution class substations. Thus, that substation class experienced a higher percentage of all animal-caused faults than expected based on the proportion of 15 kV substations in the state.

Regardless of their susceptibility, the 15 kV class substations are one of the most common distribution substations used by electric utilities in New York, and thus are very important components of the statewide electric distribution system. Because of the importance of this class of substation to the utilities and because over half of all animal-caused faults occur in them, 15 kV class substations represent the most important class of substations from the perspective of preventing animal-caused faults.

Habitat characteristics within and around substations were examined to determine whether those characteristics could be used to identify susceptible substations. No distinguishing habitat characteristics were identified. Trees or shrubs contacting or hanging over the substation fence increased the opportunity for animals to gain access to substations, but such conditions were found for only 40% of the faults reported. In addition, the type of ground cover inside the substation fence differed little among substations and likely was not an important influence on whether animals could gain access to substation equipment after the animals were inside the substation fence. Because various landscaping practices were used around substations in which animal-caused faults occurred, changes in landscaping practices likely would have little influence on whether animals could gain access to a substation. Finally, substations in which animal-caused faults occurred were located in a variety of general

cover types in urban, suburban, and rural areas. Overall, the general habitat in which the substation was sited did not seem to influence whether an animal-caused fault occurred in the substation, or on what species of animal caused the fault.

When considering whether preventive measures are warranted, utilities consider the impact of the faults on their customers. Customers lost service as a result of 83% of the faults for which customer service information was available. For each of those faults, an average of 2,388 customers of all types (e.g., residential, commercial, industrial) lost service, and 19,468 kW hr of lost service was experienced.

Total cost, to utilities, of animal-caused faults included lost revenue associated with loss of service to customers in addition to cost of replacement parts, cost of labor, cost of operating the vehicles used in investigating and repairing the faults, and administrative costs associated with customer complaints. The mean total cost[4] of each animal-caused fault was $12,550 excluding overhead and indirect costs. By accounting for overhead and indirect costs and extrapolating back to 1970, the total cost incurred by the 6 participating utilities from 1970-1988 may have been as high as $10 million.

DAMAGE CONTROL IMPLICATIONS

These data represent the first characterization of animal-caused faults in substations in New York. The costs to utilities associated with investigating and repairing these faults is high, and the occurrence of faults decreases the capability of utilities to supply electric energy to their customers. As operating costs continue to increase and as demand for electricity begins to out-pace generating capacity (Douglas 1986), utilities increasingly will be concerned about stopping "preventable" faults such as animal-caused faults in substations. Because most of the animals causing faults in substations are wildlife species, the utilities will be turning to wildlife management agencies and wildlife damage control specialists for assistance and ideas.

Often, wildlife managers faced with a damage control problem turn to 1 of 3 strategies: (1) removal of the offending animal species, (2) alteration of the habitat in the area of concern to make it unappealing to the offending animal species, or (3) use of physical barriers to prevent the offending animal species from gaining access to or contacting the area of concern. Data from this study indicate that the first 2 strategies are not appropriate techniques to use for preventing animal-caused faults in electric substations.

Limited attempts by utility representatives to remove offending animals (e.g., squirrels and raccoons) from around specific substations proved to be difficult and ineffective. Many of the substations in which faults occurred were sited in urban areas where harvest through hunting was not possible and where live-trapping resulted in the capture of mostly non-target animals (e.g., skunks and oppossums). In many of those areas, live-trapping was unacceptable because of social concerns about catching pets. Even when target animals were captured, new individual animals likely immigrated into the area.

Examination of site data within and around substations in which animal-

[4]Costs were standardized to 1987 dollars.

caused faults occurred revealed that habitat alterations would have little influence on preventing offending animal species from entering substations. More than one-half of the faults occurred in substations around which the vegetation had been pruned away from the substation fence. Substations fences were designed to prevent humans from entering substations, birds and climbing animals were not detered by fences made of brick, chain-link, or aluminum flashing. Faults even occurred in substations enclosed inside buildings.

Findings from this study indicate that the most effective preventive measures may be those that protect the types of substation equipment that experience the most faults. Buswork, circuit breakers, transformers, and capacitors experienced 74% of the faults and accounted for 85% of all costs incurred by the utilities from animal-caused faults. Protection of these types of substation equipment would do much to help utilities decrease costs and increase reliability of service to customers.

Preventive measures are not needed in all substations. Most of the animal-caused faults recorded occurred in 5 kV and 15 kV class substations, and 15 kV class substations seemed to be most susceptible. More than one-half of all recorded faults occurred in substations that had been in operation for 16-45 years. In addition, high-profile substations appeared to be more susceptible than low-profile substations. Thus, protecting high-profile, 16-45 yr old, 15 kV substations may provide a starting point for utilities which are concerned about preventing animal-caused faults, but which have limited immediate resources available to commit to preventive measures.

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