Mitigation of Animal-Caused Outages for Distribution Lines and Substations

TE-114915

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November 23, 1999

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CITATIONS

This document was prepared by

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Fort Collins, Colorado 80525-3479

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This document describes research sponsored by EPRI.

The publication is a corporate document that should be cited in the literature in the following manner:

Mitigation of Animal-Caused Outages for Distribution Lines and Substations, EPRI, Palo Alto, CA: 1999. Report TE-114915.

EXECUTIVE SUMMARY

Animal-caused faults on electrical systems have plagued engineers and operations personnel since power facilities were first installed. Today, mammals, birds and snakes cause a significant number of electric outages throughout North America and recent studies show animal-caused outages are increasingly common in both urban and residential areas.

The project "Mitigation of Animal-Caused Outages for Distribution Lines and Substations" was designed to better understand the types of equipment most susceptible to animal electrocutions and what mitigating measures work, thereby optimizing available resources to curtail outages. By taking a pro-active approach to mitigating outages, utilities will spare the lives of wildlife and will help address the increasing pressures on utilities from environmental groups and concerned utility customers. Electrocuting protected bird species can also result in civil and criminal charges. Reducing outages in today's competitive environment also represents an opportunity to gain a competitive edge through increased reliability and reduced operations and maintenance costs.

Specific study objectives were to:

- Determine the scope and extent of the problem.
- Determine the types of equipment most susceptible to animal outages.
- Identify contributing factors to animal-caused outages.
- Evaluate the effectiveness of existing mitigating measures.
- Collect information on utility-vendor communication regarding animal products.

The complete project includes a number of interrelated tasks to be completed in two phases. Phase 1 is included in this report and is comprised of the following tasks:

Survey to Assess the Impact of Animal-Caused Outages

A survey was conducted to gather information, which would enable evaluation of animal-caused outages and outage mitigation schemes for the following aspects of electric utility *distribution* systems:

- Substations
- Overhead lines
- Underground circuits

Detailed data were sought on the frequency and duration of animal-caused outages. Information on the types of hardware/equipment affected was also sought. Information on

benefits of animal-caused outage mitigation schemes was sought as well as utility experience (successes/failures) with specific products designed for the mitigation of outages.

The survey, after review and approval by EPRI, was mailed to a representative cross section of investor-owned, cooperative and municipal utilities throughout the U.S.

Survey responses were compiled and analyzed. Emphasis was placed on quantifying the various types of animal-caused outages on overhead and underground (UG) distribution systems and substations. A copy of the survey mailed to utility companies is provided in Appendix A. The results of the survey were analyzed and are provided in Section 2 of this interim report.

Surveys of Manufacturers to Determine (and Improve) User/Vendor Communication

In addition to the survey of utilities, two additional surveys were conducted. The first (identified as Survey A and provided in Appendix A) was prepared for manufacturers of overhead and underground distribution and substation equipment and products (e.g. poles, transformers, breakers, etc.). The second survey (identified as Survey B and provided in Appendix A) was mailed to manufacturers of products used on lines and substations toward the mitigation of animal-caused outages. Data from these surveys will be used as a basis for improving user/vendor communications (e.g. improved product specifications and use guidelines, feedback on product successes and failures, need for new and/or enhanced products, etc. The results of these surveys were analyzed and are provided in Section 3 of this report.

Survey Results

All the utilities who responded to the survey experience animal-caused outages on portions of their system. Accordingly, most (77%) have structured programs to combat animal problems. Although these programs vary in their sophistication, most utilities (65%) feel their programs are effective in controlling animal problems. Thirty-four of 84 utilities (40%) state animal-caused outages are staying constant, 30 utilities (36%) state outages are declining. Outage duration data provided by 33 utilities support this, with the percent of annual animal-caused problems dropping from 7.5% to 7.1% from 1993 through 1997. Outage frequency data provided by 27 utilities were more variable, fluctuating between 7.5% and 9.6%.

Utilities report consumer reliability issues primarily trigger them to install animal deterrents. Over 80% of the utilities state outage frequency and consumer complaints are the most important factors triggering them to install animal deterrents. Surprisingly, Federal/State laws and impacts to wildlife species rated the lowest concerns although the U.S. Fish and Wildlife Service has made the elimination of raptor electrocutions one of their national priorities. Recently a cooperative was charged with seven violations of the Migratory Bird Treaty Act and six violations of the Bald and Golden Eagle Protection Act for electrocuting 12 golden eagles, four ferruginous hawks, and one great horned owl, from January 1996 to June 1998. Maximum criminal penalties for misdemeanor violations of the Bald and Golden Eagle Protection Act include fines up to $200,000 per organization and up to one year of imprisonment.

Although outages create financial problems for electric utilities, very few utilities (19%) have a structured method to calculate animal-caused outage costs. Additionally, few utilities (22%) perform any cost analysis prior to implementing programs to control animal problems. Annual outage data provide by six utilities for approximately 1.8 million consumers indicate that the average annual animal-outage cost per consumer is approximately $0.39. According to the EEI Pocketbook of Electric Utility Industry Statistics, there were 120 million consumers served by the total electric utility industry in 1996. If the costs in this study are representative of the entire industry, animal problems result in $46,800,000 per year. This estimate is probably low since outage sources classified as "unknown" likely include additional animal problems not accounted for in this estimate.

Most outage duration and frequency problems caused by animals are associated with overhead distribution facilities. Utilities in this study report that approximately 73% of their animal-caused outage time and 79% of their outage events occur on distribution facilities. Tree squirrels contacting energized wires/apparatus cause the greatest animal economic impact for 40 utilities (52%). Birds contacting energized wires/apparatus cause the second greatest animal economic impact for 12 utilities (16%). Utilities report climbing mammals cause most problems in both outage duration (60%) and frequency (64%). Most utilities (63%) indicate that certain circuits are more prone to animal problems due to their location and habitat.

The most problematic overhead devices are power transformers. More utilities (39 out of 76) list transformers in their top five list of problems than any other device. They estimate transformer animal outages result in their greatest percentage of outage time (57%) and are most often caused by tree squirrels and raccoons.

The most common mitigating measure used to combat overhead outages are bushing covers (54 utilities, 74%) and insulated jumper/stinger covers (47 utilities, 64%). Utilities rate covers and insulated jumper/stinger covers as very good in mitigating animal problems. Utilities rate insulated jumpers as very good in long-term durability, but bushing covers rate lower, as good. Six utilities state that they would like to see products such as bushing covers more resistant to ultraviolet degradation and noted tracking problems with deteriorated bushing covers.

Other mitigating measures employed on distribution overhead systems include a variety of insulating measures, barriers/spikes, grounding solutions, and perching/nesting management. In general, most these measures averaged a ranking of either good or very good and there was no dissatisfaction for any product. Although 15 products were rated as very good in both mitigation success and long-term durability, no product received an overall excellent rating. Fake predators (e.g. plastic owls, hawks, etc.) received a poor rating for long-term durability after pest species became habituated.

Fewer animal-caused outage duration and frequency problems are associated with underground distribution facilities. Utilities in this study report that approximately 11% of their animal-caused outage time and 7.6% of their outage events occur on underground facilities. Animals chewing underground primary cable cause the greatest animal economic impact for 15 utilities (30%). Animals chewing underground secondary cable cause the second greatest animal economic impact for five utilities (10%). Utilities report mammals cause most problems in both

outage duration (76%) and frequency (76%). Snakes also cause problems in both outage duration (14%) and frequency (16%). Insects are responsible for 5% of outage duration and 2% frequency. Most utilities (58%) indicate that certain circuits do not appear to be more prone to animal problems.

The most problematic underground facilities are underground primary and secondary cable. More utilities (29 out of 50, 58%) list primary cable in their top five list of problems than any other item. Utilities estimate primary cable animal outages result in their greatest percentage of outage time (50%) and are most often caused by gophers.

The most common mitigating measure used to combat underground outages are burying cable in conduit (15 utilities, 26%), using duct sealant (14 utilities, 25%), and using pad mounted ground sleeves (14 utilities, 25%). Utilities report conduit and duct sealant as very good in preventing animal-caused outages. Conduit also rates very good in long-term durability; duct sealant rates good. Pad mount ground sleeves rate good in deterring animals and very good in long-term durability. No product received an overall excellent rating. Although sample sizes are low (five utilities), there is dissatisfaction with the long-term durability of poisons because they must continually be reapplied. This is problematic when facilities are located in remote areas. Metal mesh embedded cable to deter rodent chewing received a poor rating from two utilities.

Fewer animal-caused outage duration and frequency problems are associated with distribution substations. Utilities in this study report that approximately 11% of their animal-caused outage time and 7% of their outage events occur on substations. Utilities report climbing mammals cause most problems in both outage duration (48%) and frequency (39%). Tree squirrels and raccoons cause most mammal problems. Squirrel problems appear to be elevated in the spring due to nesting and during fall as squirrels prepare for winter. Birds also cause problems in both outage duration (29%) and frequency (39%). Bird problems appear to be elevated in the spring due to nesting and during fall migration as large numbers of birds' concentrate. Unfortunately, utilities are generally not able to differential bird species and list most problem species as unknown. Snakes also cause significant problems in both outage duration (23%) and frequency (20%).

Fifty percent of responding utilities indicate that certain substations are more prone to animal problems. Certain substations are more problematic either due to local habitat (53%) or substation configuration (28%). Most substation problems (84%) occur on the low side versus the high side (16%). One utility states only 186 of their 688 substations (27%) have experienced an animal caused outage within the past 10 years. Of these, 15 substations (2%) are responsible for 26% of all their substation outages and are more prone due to their location and associated habitat. These substation outages cost the utility an average of $15,000 each in 1997, excluding overhead and indirect costs.

Areas with heavy tree density are also identified as having more squirrel problems. One utility states animal problems increase after new development destroys habitat and animals emigrated from the disturbed area. They noted 83 of their substations experienced 50% more outages when nearby wooded areas came under development. Increasing outages due to seasonal animal migrations were also noted. Some utilities indicate older substations are more prone to outages.

The most problematic substation facilities are breakers/reclosers, power transformers, and bus conductors. These facilities received similar rankings, with 19 to 23 utilities placing them in their list of top five problem items. More utilities (23 out of 48) list breakers/reclosers in their top five list of problems than any other item. Utilities estimate breaker/recloser animal outages result in their greatest percentage of outage time (44%) and are most often caused by tree squirrels and raccoons.

Many older substations have numerous cavities providing nesting places for birds. The availability of young birds and eggs in substations attracts other problem animals such as owls and raccoons. Accordingly, the most common substation mitigating measures reported by 56 respondents are regular substation bird nest removal (71%) and regular substation perimeter vegetation trimming (59%). Utilities rate mitigation success as very good and long-term durability as good. The use of insulating methods is also common with utilities using insulated bushing covers (57%), insulated jumper/stinger covers (43%), heat-shrink insulation material (27%), and insulating tape (23%). All these methods rate very good in effectiveness and durability. Insulated primary wire (13%) rates as excellent in both effectiveness and durability. Insulating paints (11%) and sprays (4%) were used less frequently and had lower rankings.

A variety of barriers and spikes are used with success and durability ranging from good to very good. Insulated disk barriers are rated excellent for success by one utility. Substation fence modifications (e.g. small-mesh screening, burying fence fabric, snake fences, and electric fences) also rate good to very good in success and durability.

The most common measures to mitigate substation underground problems reported by 56 respondents are burying cable in conduit (25%), using duct sealant (25%), and pad mounted ground sleeves (14%). Utilities report conduit, pad mount ground sleeves, and metal mesh as very good in preventing animal-caused outages and durability. Duct sealant rates good in deterring animals and long-term durability.

Sonic distress calls (7%), fake predators (30%), iridescent foil visual deterrents (2%) all rate as good in success but poor in long-term durability. Ultrasonic pest repellers (18%) rate poor in both mitigation success and durability. Strobe light animal deterrents were used by two utilities and failed to deter animals. Although some of these products initially have limited success, animals soon become acclimated to these devices and return.

Original Equipment Manufacturer's (OEM's) and companies manufacturing animal mitigating products were contacted to collect information on utility-vendor communication regarding animal products. OEM response was low with only 16 responses (9%). Five OEM's indicate specific animal options are available for their products. These products are designed to control a variety of animals and increase product costs up to 10%. Six OEM's state they give serious consideration to minimizing the potential for animal-caused outages when developing new products. Trade shows, sales calls, and catalogs are used most frequently to promote general products and advertising is primarily targeted towards standards engineers, engineering and operations management, purchasing agents, and staff engineers.

Thirteen companies manufacturing animal mitigating products (21%) also responded to the survey and provided information on 45 different animal mitigating products. The most commonly listed controlled mammal species are tree squirrels, ground squirrels, raccoons, opossums and rats. Tree squirrels were listed most frequently with 20 products available. Bird-control measures primarily target birds-of-prey, blackbirds, gulls and pigeons.

The development of outage mitigating products is a new emerging market according to survey responses. Most products (73%) have been on the market for less than 10 years and 21 products (46%) have become available only within the last five years. Catalogs, trade journals, trade shows and word of mouth are used most frequently to promote these products. Advertising is primarily targeted towards standards engineers, linemen, engineering management and staff engineers. Although environmental staff may also often be involved in solving animal problems, they are targeted less frequently. The companies also state 28 products (62%) have increasing market demand.

Although many animal protection products are manufactured to comply with the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE) and/or the American Standard of Testing and Materials (ASTM) standard products, there are few developed standards specific to animal protection devices themselves. Only eight of 45 products (18%) were designed subject to an ANSI standard and only two of the products (4%) are Rural Utilities Service (RUS)-approved. Although few standards exist, 34 products (76%) have been field and/or laboratory tested. Published field data are available for 27 products (60%). Warranties ranging from one to five years are also offered for 32 products (71%).

Manufacturers cite the following barriers faced when developing and marketing new animal-caused outage mitigating products:

- Cost (due to expensive design and testing).
- Poor utility communication describing their animal problems.
- Difficulty in developing a universal product (due to vast number of utility configurations).
- Utility hesitancy to try new products (especially without name recognition).

Despite these barriers, manufacturers state a willingness to work with utilities to develop new products. Nine companies report a total of 13 utility requests for product modifications and/or enhancements. Twelve requests were fulfilled and customers were either very satisfied or extremely satisfied. One request was not fulfilled because the customer lost interest in the product.

The manufacturers perceive product effectiveness as the most important factor to utilities, just above product cost and maintenance costs. Product life expectancy, material properties and installation labor costs were perceived as a lower utility importance although six power companies (7%) in the utility survey indicate material properties are very important and have a desire to see products with improved ultraviolet resistance.

ACKNOWLEDGEMENTS

The authors wish to express their appreciation to the EPRI Distribution Business and EPRI Power Delivery Group Business Area Council Member Utilities for their participation in this survey. Utilities, which provided critical guidance and assistance in developing and completing the animal-caused outage survey, include:

- B.C. Hydro
- Detroit Edison
- GPU Energy
- La Plata Electric Association, Inc.
- Nebraska Public Power District
- TU Electric

Several consultants, manufacturers, and governmental agencies were also key contributors to this report. Sheila Frazer of Southern Engineering and Greg Phillips provided valuable input in the development of the animal-caused outage survey. Jerry Hager of ESC was helpful with the technical details of this survey. Bob Hartman of Kaddas Enterprises provided valuable input with the two manufacturing surveys. Howard Barnes and Dennis Rankin of the Rural Utilities Service (RUS) also enthusiastically participated in the development of the surveys and 63 electric rural electric cooperatives provided valuable survey data.

A special word of thanks goes to all the EPRI-members who provided input to the survey conducted as a part of this project; there was a high return rate to the very lengthy survey that was mailed to these individuals. In particular, Mark Stockman of Detroit Edison provided a valuable amount and quality of animal-caused outage data.

The following individuals were instrumental in obtaining photographs:

- Carroll Electric Co-Op Corporation
- Jerry Hager
- Joey Mason
- Tony Povilitis
- Raychem

EPRI's financial and administration support is gratefully acknowledged. In particular, the contributions of Mr. Bruce Bernstein, Project Manager of the EPRI RP4729-02 Project, must be noted.

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1. INTRODUCTION

1.1 Background

Animal-caused faults on electrical systems have plagued engineers and operations personnel since power facilities were first installed. Today, mammals, birds and snakes cause a significant number of electric outages throughout North America and recent studies show animal-caused outages are increasingly common in both urban and residential areas.

The project "Mitigation of Animal-Caused Outages for Distribution Lines and Substations" was designed to better understand the types of equipment most susceptible to animal electrocutions and what mitigating measures work, thereby optimizing available resources to curtail outages. By taking a pro-active approach to mitigating outages, utilities will spare the lives of wildlife and will help address the increasing pressures on utilities from environmental groups and concerned utility customers. Electrocuting protected bird species can also result in civil and criminal charges. Reducing outages in today's competitive environment also represents an opportunity to gain a competitive edge through increased reliability and reduced operations and maintenance costs.

1.2 Project Objectives

Specific study objectives are to:

- Determine the scope and extent of the problem.
- Determine the types of equipment most susceptible to animal outages.
- Identify contributing factors to animal-caused outages.
- Evaluate the effectiveness of existing mitigating measures.
- Collect information on utility-vendor communication regarding animal products.

1.3 Scope of Work

The complete project includes a number of interrelated tasks to be completed in two phases. Phase 1 is included in this report. Phase 2 tasks are to be completed at a later date. Phase 1 consists of the following three tasks:

Survey to Assess the Impact of Animal-Caused Outages

A survey was conducted to gather information, which would enable evaluation of animal-caused outages and outage mitigation schemes for the following aspects of electric utility *distribution* systems:

- Substations
- Overhead lines
- Underground circuits

Detailed data were sought on the frequency and duration of animal-caused outages. Information on the types of hardware/equipment affected was also sought. Information on benefits of animal-caused outage mitigation schemes was sought as well as utility experience (successes/failures) with specific products designed for the mitigation of outages.

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Phase 2 of the project consists of the following eight future tasks:

Prepare Supplement to the NRECA Publication's Section on Animal Behavior

"Animal-Caused Outages," by Southern Engineering and published by NRECA, contains information about the behavior of a number of different species of animals and insects. A review of this document will be conducted to determine what species are not covered and whether the information for the covered species could be enhanced in any way. A supplement to expand the scope of the NRECA document will be prepared and completed by December 1999.

Prepare an Annotated Bibliography for Reference Material

Numerous articles and other documents have been prepared regarding animal-caused outage problems and associated mitigation efforts. A literature search will be conducted in an effort to compile as many titles as can be found. These titles will be categorized and a brief abstract written for each. The bibliography will be published in December 1999.

Develop an Encyclopedia of Mitigation Products and Manufacturers

A list of mitigation products and manufacturers will be compiled and a profile of each company developed. The manufacturer profiles will include company name, address, phone, fax, website, principal contact, list of products, etc. Each product listed will be described and categorized by type. Product applications, cost information, installation techniques, test data availability, effectiveness of use data and other pertinent information are to be included. Cross-reference tables for the various product categories and animal species are to be included. The encyclopedia will be completed by February 2000.

Define Animal-Caused Outage Mitigation Design Considerations for Manufacturing and Line Construction

Results from the surveys conducted under this project are to be compiled into a list of the causes of the majority of outages. The specifics for each cause will be defined and all available design solutions identified. From these analyses, a priority list of design considerations will be developed for both equipment-modification and construction-alteration type solutions. The design considerations will be published by March 2000.

Develop a "Pest Checklist" for use by Utility Personnel

Each animal or insect species has its own specific types of problems which can be correlated to a set of recommended mitigation practices. Checklists are under development for each of the studied species to identify product types and construction practices that can be used to minimize animal-caused outage problems for various system configurations used in overhead, underground and substation installations. The checklist will be completed by February 2000.

Conduct Product Testing

During an EPRI project review meeting held on February 17, 1999, interest was expressed in testing four different "products" and their effectiveness in mitigating animal-caused outages:

- The color “red” as a squirrel deterrent

The NRECA publication, “Animal-Caused Outages” infers red is a color which squirrels avoid. However, no scientific evidence was provided to support this claim. Since squirrels cause many of the outages on distribution systems, the simplicity of introducing the color red to mitigate squirrel problems warrants further study.

- Electrostatic guards

Electrostatic guards have shown promise as a barrier-type system of outage mitigation; however, there is little data to prove their effectiveness and some concerns have been expressed regarding appropriateness of use on certain hardware configurations.

- Fox urine

Interest was shown in learning if rodents are deterred by the smell of predators. Fox urine will be tested to determine if it will deter squirrels from entering enclosed areas, such as a substation.

- Fusing tape

The effectiveness of using fusing tapes to mitigate animal-caused outages has varied. These products are popular for certain applications but are not always trouble-free or reliable. Product type, environment, installation techniques, etc. are variables, which can influence the product’s long-term performance. Testing will qualify how, when and where fusing tapes can most effectively be used.

Each of these is the subject of controlled-experimentation and study to determine:

1. their effectiveness and limitations as an agent of problem mitigation, and

2. their potential for modification to improve their problem mitigation effectiveness.

Product testing is scheduled to end by February 2001.

Prepare Training Film

In general, few utility personnel have more than a rudimentary understanding of the cause and effect of animal-caused outages. In addition, many utilities test various solutions to such outages and often repeat mistakes made by other utilities in their previous attempts to solve such problems. As a means of promoting better education, a training film will be prepared which will include items such as: environmental laws pertinent to distribution construction, common outage problems and available solutions, tips on product usage, references to sources for further information, etc. The film will contain up-to-date information on these subjects, including some of the findings of the various tasks

previously conducted as part of this project. The training film will be completed by December 2000.

Conduct a Utility Workshop

At the conclusion of all of the tasks listed previously, a one- or two-day workshop will be organized and conducted (to be held at a location yet to be determined). The workshop will be structured to present the findings and recommendations of the previously completed tasks followed by a forum to discuss and define future research needs in this area.

2. UTILITY SURVEY

2.1 General Utility Background and System Outage Information

In December 1998, a survey was mailed to 878 North American utilities to evaluate the impacts of animal-caused outages. Surveys were mailed to investor-owned utilities, Rural Utilities Service (RUS) electric cooperatives, and municipal, state, and federal utilities. Eighty-four utilities (9.6%) responded to the 14-page survey (see Figure 2-1). A copy of the original survey is provided in Appendix A.

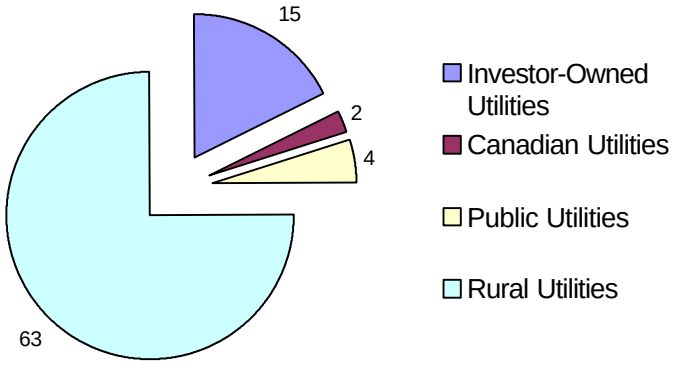


Figure 2-1. Utility Responses to the 1998 North American Animal-Caused Outage Survey.

Sixty-five of the 84 respondents (77%) state they have some kind of structured action program in place to reduce animal-caused outages. These programs vary greatly in their overall complexity. More complicated plans include on-line reporting of outages and multi-disciplinary task forces to review and prioritize budget dollars to reduce animal-caused outages. Simpler programs primarily focus on installing specific mitigating measures, such as bushing covers, only on historic problem equipment items. Only 19 utilities (23%) have no specific animal action program and simply react to problems with various retrofitting measures.

Most responding utilities (65%) deem their action program(s) effective in combating outages, stating animal-caused outages are either decreasing (37%) or staying constant (40%) (Figure 2-2). Only three utilities report increasing animal-caused outage time. One utility attributes this to increasing animal populations of starlings, ravens, pigeons and squirrels. Another utility states increasing consumer density amplifies their exposure to animal-caused outages.

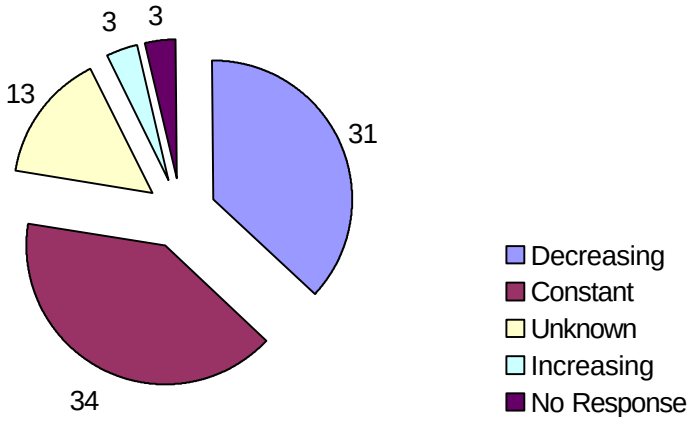


Figure 2-2. Animal Action Programs Effect on Reducing Outages.

Utilities note several reasons for successfully decreasing animal-caused outages. These include fixing existing older problem areas while improving new construction standards. Utilities also cite education of lineman and better record keeping as tools they employ to lower outage rates. On some systems, expanding sectionalizing schemes at lateral locations and transformers reduce overall outage impacts by decreasing the number of potentially impacted customers.

A variety of factors may trigger a utility to install animal deterrents. Each of the 65 utilities with a specific animal action program were asked to review and rank 12 potential factors (Table 2-1). The majority of utilities (88%) indicate outage frequency is a very important factor triggering the installation of animal deterrents, followed by consumer complaints (80%). Inconvenience to consumers, number of affected consumers, outage duration, and power quality also rate as notably important factors. In general, most utilities place a higher priority on consumer reliability issues than on their own utility problems such as damaged equipment costs and lost utility revenue. Surprisingly, Federal/State laws and impacts to wildlife species rated the lowest concerns although the U.S. Fish and Wildlife Service has made the elimination of raptor electrocutions one of their national priorities. Recently a cooperative was charged with seven violations of the Migratory Bird Treaty Act and six violations of the Bald and Golden Eagle Protection Act for electrocuting 12 golden eagles, four ferruginous hawks, and one great horned owl, from January 1996 to June 1998. Maximum criminal penalties for misdemeanor violations of the Bald and Golden Eagle Protection Act include fines up to $200,000 per organization and up to one year of imprisonment.

Table 2-1. Importance of Factors Triggering the Installation of Animal Deterrents.

Factors Triggering the Installations of Animal Deterrents	Very Important	Moderately Important	Somewhat Important	Not Important
Outage frequency	88%	12%	0%	0%
Consumer complaints	80%	14%	6%	0%
Inconvenience to consumers	69%	25%	6%	0%
Number of affected consumers	69%	25%	6%	0%
Outage duration	67%	23%	8%	2%
Power quality	66%	22%	12%	0%
Damaged equipment cost	58%	30%	6%	6%
Economic impact on consumers	44%	31%	23%	2%
Liability issues	33%	29%	28%	10%
Lost utility revenue	33%	27%	24%	16%
Federal/State environmental laws	23%	36%	26%	15%
Impacts to wildlife species	21%	32%	33%	14%

Although 65 utilities have animal action programs in place to reduce animal-caused outages, only 14 utilities (22%) performed any cost analysis prior to implementing various portions of their program. Additionally, most utilities (63%) do not have any structured method to determine animal-caused outages costs (Table 2-2).

Table 2-2. Number of Utilities Using a Structured Method to Calculate Outage Costs.

Method for Calculating Outage Costs?	Number Utilities
Yes	16
No	53
Unsure	15

The 16 utilities using a structured method to determine annual animal-caused outage costs were asked to identify factors determining outage costs (Table 2-3). Although utilities show a high sensitivity to consumer reliability issues, these utilities primarily employ cost outage factors directly related to utility impacts such as lost revenue, damaged equipment costs, and labor to locate and repair damaged equipment and clear faults. Factors impacting customers, such as consumer relations and type of customer, were included in fewer calculations.

Table 2-3. Methods used to Calculate Outage Costs.

Outage Cost Factors	Number of Utilities
Lost utility revenue	12
Labor to locate and clear faults	11
Damaged equipment cost	10
Labor to repair damaged equipment	10
Location (e.g. urban, rural)	8
Economic impact on consumers	7
Impact to consumer relations	5
Type of customer	4
Time of day, week, or year	4
Outside temperature	1
Civil litigation/fines	1

Six utilities provided outage costs associated with animal outages from 1993 through 1997 (Table 2-4). These utilities collectively serve approximately 1.8 million consumers and animal-caused outages cost them between $440,056 in 1996 to $989,018 in 1994. The average annual animal-caused outage cost per consumer is $0.39. These data clearly demonstrate animal-caused outages annually have a significant financial impact on the utility industry. Reducing outages in today's competitive environment represents an opportunity to gain an edge on the market through increased reliability and reduced operations and maintenance costs.

Table 2-4. Animal-Caused Outage Costs Reported by Six Utilities

Utility	1993	1994	1995	1996	1997
Utility 1 - Number Consumers			5,194	5,200	5,237
Animal Outage Costs			$1,159	$2,438	$2,468
Utility 2 - Number Consumers		11,724	11,771	11,841	12,014
Animal Outage Costs		$1,669	$235	$47	$66
Utility 3 - Number Consumers	1,397,154	1,439,204	1,473,146	1,502,640	1,534,601
Animal Outage Costs	$312,000	$559,650	$278,850	$294,450	$718,900
Utility 4 - Number Consumers	7,158	7,241	7,373	7,413	7,442
Animal Outage Costs	$266	$308	$336	$140	$303
Utility 5 - Number Consumers	305,640	309,422	310,395	311,235	313,495
Animal Outage Costs	$319,000	$412,800	$293,700	$128,800	$175,000
Utility 6 - Number Consumers	9,706	9,983	10,481	10,846	11,207
Animal Outage Costs	$14,291	$14,591	$14,522	$14,181	$13,743
Total - Number Consumers	**1,719,658**	**1,777,574**	**1,818,360**	**1,849,175**	**1,883,996**
Animal Outage Costs	**$645,557**	**$989,018**	**$588,802**	**$440,056**	**$910,480**

Utilities were asked if retrofitting electric facilities to mitigate animal problems resulted in any new unexpected problems. Eighteen utilities (21%) report new outage or maintenance problems (Table 2-5). The most common complaints pertain to outages caused by deteriorating bushing covers (8%). Utilities complain that some covers do not withstand long-term ultraviolet radiation exposure and/or environmental contamination (Photo 2-1). It is important to note although several bushing cover problems are noted, bushing covers are also listed as the most common distribution overhead and substation mitigating product (see Sections 2.1.1 and 2.1.3). Improperly installing bushing covers below the first insulator skirt also resulted in flashovers for one utility. Insects nesting in bushing covers and birds becoming electrocuted probing for insects were also noted. Maintenance problems included bushing covers hiding loose connections, lightning damage, and interfering with infrared inspections. Other problems include retrofitting products coming loose (Photo 2-2) and difficulty working around products such as spikes, pole wraps, and snake fences. The following table provides the identified retrofitting problems.

Table 2-5. New Outage or Maintenance Problems Resulting from Retrofitting.

New Outage or Maintenance Problem	Number of Utilities Reporting the Problem
Bushing covers deteriorating and tracking.	6
Bushing covers hiding loose connections.	1
Bushing covers hiding lightning damaged insulators.	1
Insects nesting in bushing covers.	1
Birds probing for insects in bushing covers, resulting in electrocutions/outages.	2
Heat shrink material reducing the effectiveness of infrared inspections.	1
Equipment coated with rubber paint requires additional time to disassemble.	1
Braided insulated jumper wires breaking in the wind.	1
Improper operation of a spark gap arrester due to incorrectly installed transformer animal guards.	1
Transformer animal guard grounding out a high side bushing.	1
Animal guards falling off transformer bushings.	1
Birds nesting on bird guards/spikes.	1
Spikes falling off crossarms	1
Squirrels nesting under transformer animal guards.	1
Difficulty climbing over mastic pole wraps.	1
Difficulty working around animal spikes.	1
Plastic pole wraps coming loose in the wind.	1
Eagle perches falling off mounting brackets.	1
Raptor perch guards collapsing.	1
Substation snake fences tripping workers.	1
Sonic distress alarms irritating neighbors.	1



Photo 2-1. New (left) and Deteriorated (right) Bushing Covers.



Photo 2-2. Elevated Raptor Perch Coming Loose from the Pole Top.

Sixteen utilities (19%) indicate they would like to see modifications to existing products or the development of new products to mitigate animal-caused outages (Table 2-6). The most common request is for products with improved ultraviolet resistance. A desire for custom products easy to

install is also noted. The list of requests also includes a desire for horizontal post insulator shields, underground riser conduit end fittings, insulated transformer lids, and products to eliminate raptor nesting and contacting phase wires. These products already exist and demonstrate a need for improved user/vendor communication (see Section 3.2.2). Some utilities have resorted to home remedies (Photos 2-3 and 2-4) despite the availability of existing products. Twenty-two utilities (26%) state they do not see any need for modifications or new products; forty utilities (48%) are unsure. The requests are provided in Table 2-6.

Table 2-6. Utilities Requesting Modifications to Existing or New Products.

Proposed Modification or Product	Number of Utilities Requesting the Solution
Products more resistant to ultraviolet degradation.	4
Larger bushing covers for substation transformers and breakers.	2
Heat shrinkable bushing covers easy to install.	2
Heat shrinkable gapped/non-gapped arrester covers that are easy to install.	1
Custom made acrylic cover up products.	1
Horizontal post insulator shields.	1
Shields to reduce fecal contamination.	1
Arrester exhaust vent barriers to restrict bird perching and nesting.	1
End fittings for UG riser conduits to keep out tree squirrels.	1
Insulated distribution transformer lids.	1
Products to eliminate birds from contacting phase wires mounted on steel crossarms.	1
Products to eliminate raptors from nesting on crossarms.	1
Effective barriers for substation equipment footings.	1
More effective snake mitigating measures.	1
Products than can be installed hot with one lineman.	1
Monitoring tools to identify where birds are contacting facilities	1



(Photo by:Joey Mason)

Photo 2-3. Utility Remedy to Discourage Ospreys from Nesting on Overhead Structures.



(Photo by: Tony Povilitis)

Photo 2-4. Utility Remedy to Discourage Owls from Contacting Energized Facilities.

Outage statistics were compiled to determine the impact of animal-caused outages on system reliability. Animal-caused faults are of special concern because many are preventable and present an opportunity to improve system reliability. Each utility was asked to review a list of typical outage causes and estimate both outage **duration and frequency** from 1993 through 1997.

Outage **duration** statistics were provided by 33 (39%) utilities for 1993 and increased to 45 utilities (55%) for 1997 (Table 2-7). These data were obtained annually from approximately 10 to 11 million electric consumers. Weather problems (lightning, storms, wind, and ice/snow) are responsible for the greatest duration of reported outages spanning the five-year period, ranging from 28 to 33% of all outage time. Unknown and miscellaneous outages account for the second greatest problem with 26 to 30% of all outage duration. Tree problems are responsible for approximately 14-15% of outage time.

Table 2-7. Outage Duration Percentages for Each System Outage Cause from 1993 to 1997.

Typical Outage Causes	1993 Outage Duration (Percent)	1994 Outage Duration (Percent)	1995 Outage Duration (Percent)	1996 Outage Duration (Percent)	1997 Outage Duration (Percent)
Species - Birds	1.7	1.6	2.3	1.8	1.3
Species - Mammals	1.5	1.4	1.5	1.3	1.1
Species - Reptiles	0.2	0.2	0.3	0.2	0.2
Species - Unknown	4.1	3.6	3.5	3.7	4.5
Animal Total	**7.5**	**6.8**	**7.6**	**7.0**	**7.1**
Lightning	11.7	9.9	10.8	11.0	11.3
Storm	8.9	11.4	4.4	5.2	3.9
Wind	6.5	6.2	8.2	10.3	9.5
Ice/Snow	3.7	5.8	4.8	4.8	6.9
Weather Total	**30.8**	**33.3**	**28.2**	**31.3**	**31.6**
Trees	15.4	13.7	14.7	14.6	14.5
Vehicle Accident	3.2	2.8	2.9	2.7	3.4
Equipment	8.2	6.7	8.2	8.0	10.2
Power Supply	3.8	3.2	4.0	5.8	3.3
Scheduled	2.8	3.8	2.7	2.99	3.6
Miscellaneous Other	18.8	20.4	23.0	18.2	15.9
Unknown	9.5	9.3	8.7	9.5	10.4
Total	100%	100%	100%	100%	100%
Number Reporting Utilities	33	38	36	43	45
Duration Hours/Consumer/Year	1.29	1.47	2.38	2.02	2.92
Number Consumers	10,114,193	10,490,752	10,653,476	10,832,112	11,105,625

Animals are responsible for approximately 7% of all outage duration from 1993 through 1997. These animal outage estimates are conservative since unknown outages account for nine to 10% of all outage time and likely includes additional undetected animal problems. The NRECA document “Animal-Caused Outages” estimates between one-third and three-fourths of unknown or unexplained outages are the result of animal contacts.

Most animal outages are not identified by a species grouping and are listed as “unknown.” However, when utilities identified species, birds are identified more often than any other animal (Figure 2-3). Bird electrocutions also have more annual variation than other animals, with a low of 1.3% and a high of 2.3%. Mammal outages fluctuate minimally with values ranging from 1.1 to 1.5%.

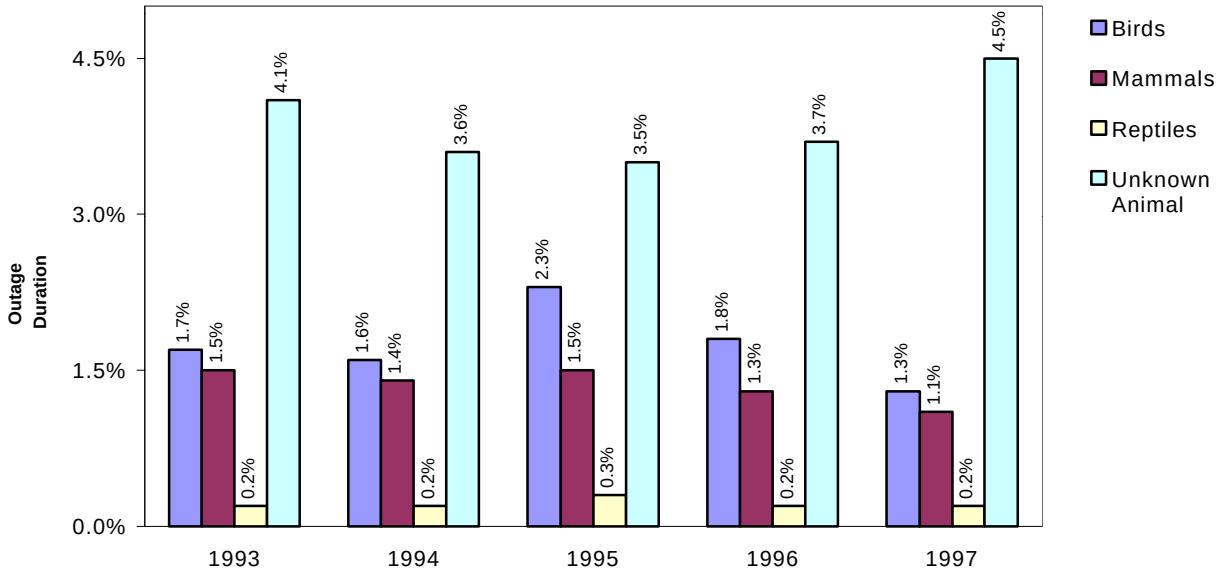


Figure 2-3 Percent Outage Duration by Animal Grouping from 1993 through 1997.

Outage **frequency** statistics were provided from 27 utilities (32%) for 1993 and increased to 34 utilities (40%) for 1997 (Table 2-8). These data were obtained annually from approximately 10 to 11 million electric consumers. Unknown and miscellaneous outages accounted for the greatest outage frequency, ranging from 28 to 34% of all outage events. Weather problems (lightning, storms, wind, and ice/snow) were the second greatest problem with 26 to 32% of all outage incidents. Tree problems were responsible for approximately 13 to 17% of outage frequency.

Table 2-8. Outage Frequency Percentages for Each System Outage Cause from 1993 to 1997.

Typical Outage Causes	1993 Outage Duration (Percent)	1994 Outage Duration (Percent)	1995 Outage Duration (Percent)	1996 Outage Duration (Percent)	1997 Outage Duration (Percent)
Species - Birds	1.1	1.6	1.2	1.0	1.6
Species - Mammals	0.9	1.1	1.4	1.4	1.6
Species - Reptiles	0.1	0.1	0.1	0.1	0.2
Species - Unknown	5.4	6.8	6.0	6.1	6.2
Animal Total	**7.5**	**9.6**	**8.7**	**8.6**	**9.6**
Lightning	10.5	9.9	12.9	10.2	11.7
Storm	6.9	14.5	7.0	8.4	6.5
Wind	6.5	3.7	3.2	4.4	5.0
Ice/Snow	2.2	3.6	3.6	2.5	2.2
Weather Total	**26.1**	**31.7**	**26.7**	**25.5**	**25.4**
Trees	15.9	12.5	14.1	15.6	17.4
Vehicle Accident	3.5	3.7	3.0	2.9	3.2
Equipment	10.1	8.3	9.5	11.8	9.5
Power Supply	0.8	0.7	1.3	3.0	1.8
Scheduled	2.7	3.0	2.8	4.0	4.4
Miscellaneous Other	24.4	22.5	25.5	19.4	18.4
Unknown	9.0	8.0	8.4	9.2	10.3
Total	100%	100%	100%	100%	100%
Number Reporting Utilities	27	29	29	33	34
Events/Consumer/Year	.70	.77	.81	.84	.71
Number Consumers	10,358,811	10,658,399	10,845,428	11,424,810	9,769,294

Animals were responsible for approximately 9% of all outage events from 1993 through 1997, compared to 7% of all outage duration time. An average of 815,000 consumers were impacted annually by these animal-caused outages.

Most animal outages were not identified by a species grouping and were listed as “unknown”. However, birds were identified more often than any other listed species in 1993 and 1994 (Figure 2-4). The following two years, mammals surpassed bird incidents. In 1997, bird and mammal incidents were equal as bird outages increased to 1.6%. These changes may represent yearly fluctuations in bird and mammal populations due to climatic and other environmental changes.

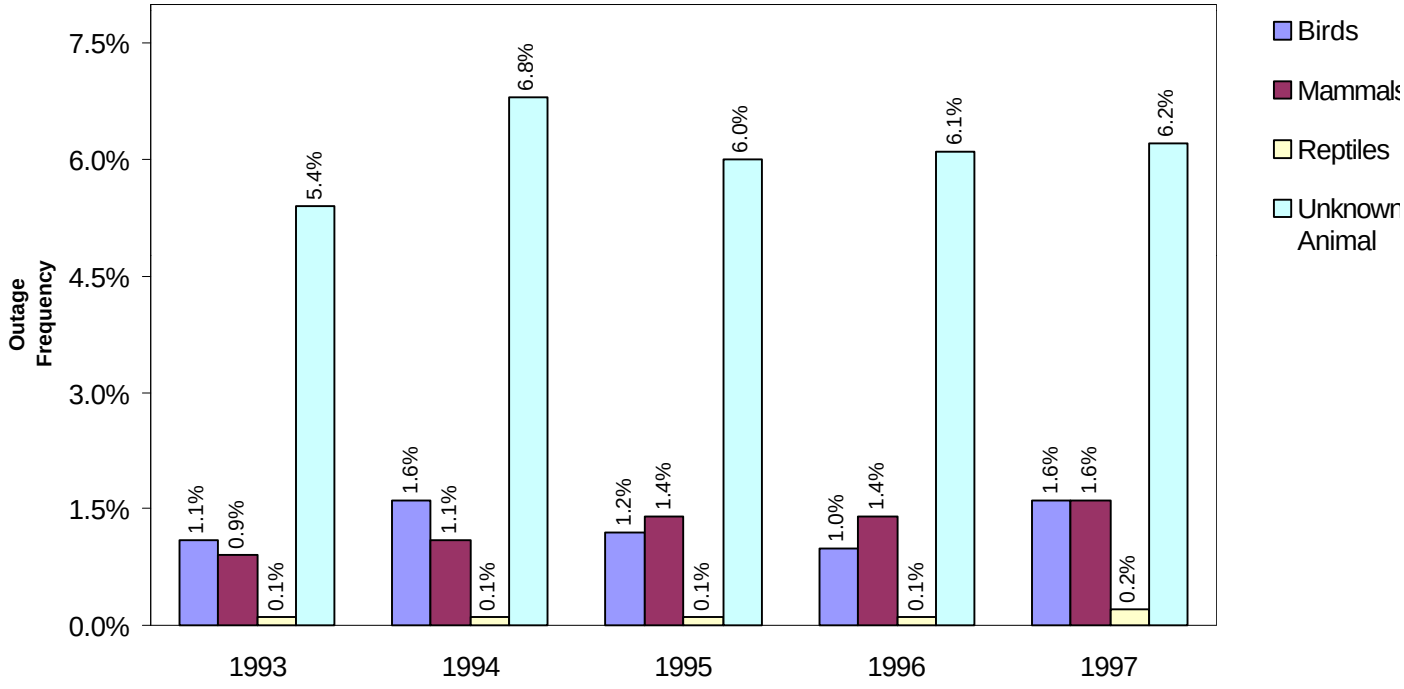


Figure 2-4 Percent Outage Frequency by Animal Grouping from 1993 through 1997.

Most utilities report seasonally elevated animal-caused outages (Table 2-9). Utilities distributed across North America report elevated bird problems in spring, summer, and fall (Figure 2-5). Insufficient data were received to determine any geographic pattern. Eleven utilities (13%) describe increasing bird problems during the spring, associated with breeding and nesting. Two utilities in the northwestern United States report increasing osprey nesting problems, particularly at river crossings (Photo 2-5). Six utilities describe increasing bird problems during the fall as birds concentrate in large numbers preparing to migrate. Large flocks of birds cause problems when landing and defecating on utility equipment. Large flocks of birds simultaneously flying off conductors also cause some conductors to gallop, resulting in outages (Photo 2-6).

Table 2-9. Utilities Reporting Seasonally Elevated Outages.

Outages Elevated at Certain Times of the Year?	Number Utilities
Yes	55
No	15
Unsure	13

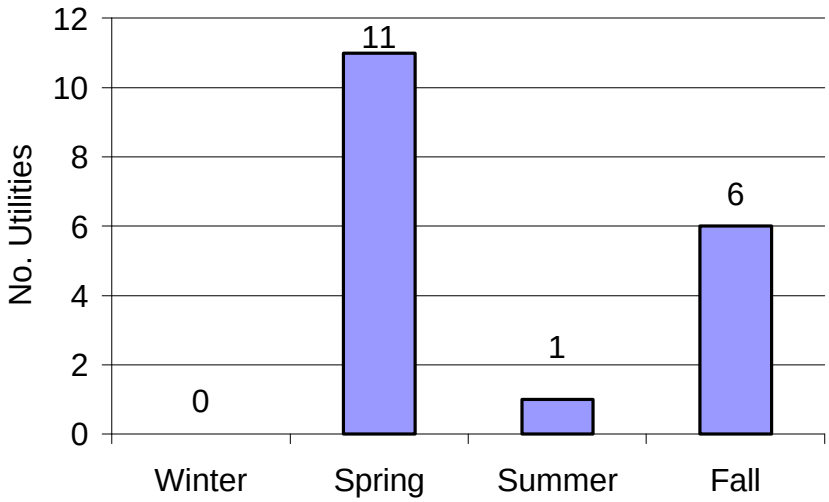


Figure 2-5. Utilities Reporting Seasonally Elevated Bird Problems.



(Photo by Jerry Hager)

Photo 2-5. Osprey Nesting on a Three-Phase Recloser Pole.



Photo 2-6. Migrating Blackbirds on Powerlines Can Cause Conductor Galloping and Outages When They Disperse.

Six utilities (7%) describe increasing squirrel problems during spring associated with young squirrels dispersing and seeking new territories. Three utilities (4%) report elevated summer problems. Ten utilities (12%) describe increasing squirrel problems during the fall, associated with nest building and collecting and storing food (Figure 2-6).

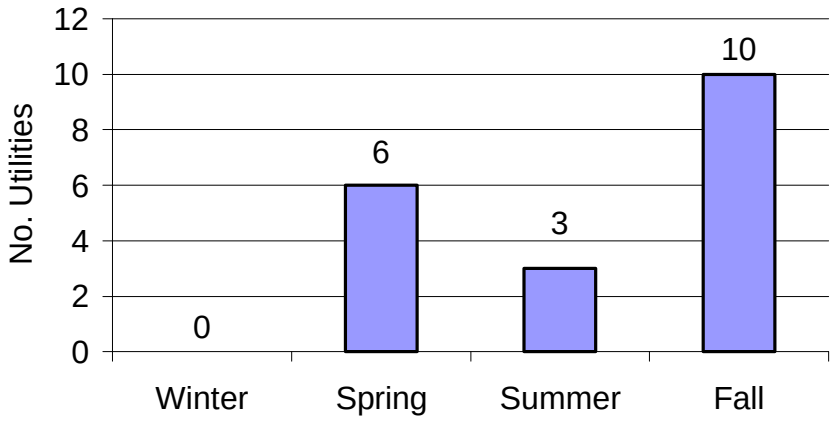


Figure 2-6. Utilities Reporting Seasonally Elevated Squirrel Problems.

Utilities in Oklahoma, South Dakota, and Texas report increasing snake problems during the summer. Substation outages occur when snakes climb substation equipment and contact energized hardware or conductors. These utilities observed snakes climbing substation equipment pursuing birds, eggs and nestlings.

One utility provided detailed substation outage data between 1985 and 1994. These outages provided dates and time-of-day data for approximately 57 bird and 286 animal outages. Bird outages occurred most frequently in May and primarily occurred during the daytime. Bird outages occurred from early dawn to dusk, peaking at noon. Mammal outages occurred frequently in April, May, and June. During the summer months, mammal outages dropped and then peaked in October and November. Mammal outages occurred both during the day and evening. Although most mammal outages occurred between the hours of 7 AM and 3 PM, another period of activity was noted at midnight for raccoons and opossums.

Utilities were asked to estimate the percent of their historic animal-caused outages (frequency and duration) occurring on overhead distribution lines, underground distribution circuits, substations, and transmission lines between 1993 and 1997. Forty-four of 84 utilities (52%) estimate overhead distribution lines are associated with 73% of historic animal-caused outage duration (Figure 2-7); transmission systems (4.6%) display the lowest duration. Most of these data do not include momentary outages cleared by recloser and breaker operations. Many utilities do not classify an interruption as an outage until its duration exceeds approximately five minutes. Only 12 of the 84 utilities (14%) include momentary trips in their outage records.

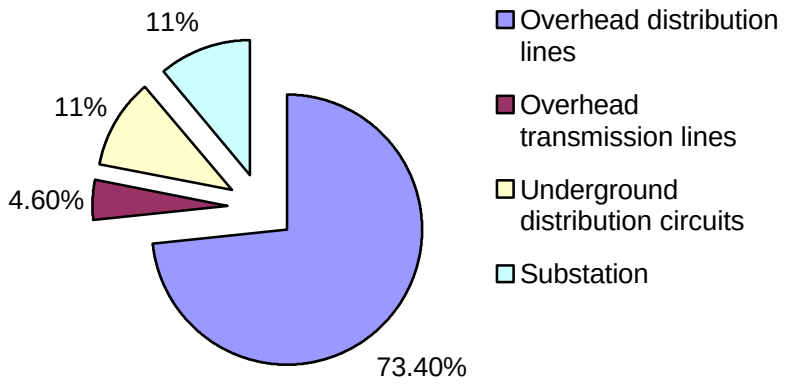


Figure 2-7. Estimated Percentage of Animal-Caused System Historic Outage Duration.

Thirty-five of 84 utilities (42%) estimate overhead distribution lines are associated with 79% of historic animal-caused outage events (Figure 2-8); transmission systems (6.5%) again are the fewest. Although underground distribution circuits and substations account for a smaller percentage of outage events, they comprise a greater percentage of outage duration. Underground circuits are responsible for 7.6% of animal events and 11% of outage time. Substations are responsible for 7.3% of animal events and also 11% of outage time.

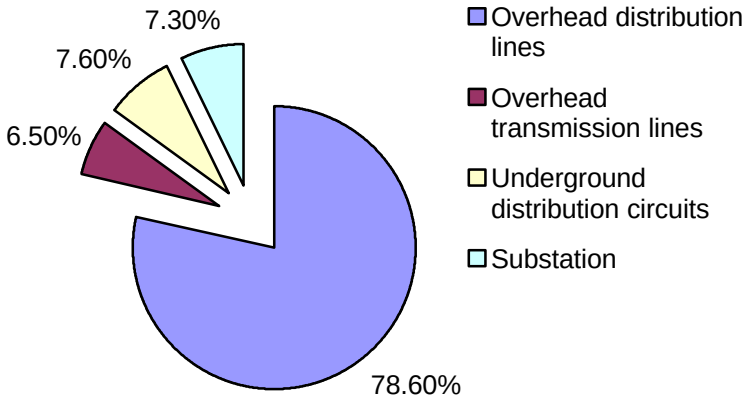


Figure 2-8. Estimated Percentage of Animal-Caused System Historic Outage Frequency.

2.1.1 Overhead Distribution Animal-Caused Outages

Utilities were provided a list of 12 historic distribution animal problems and asked to identify specific animal-caused overhead outage problems causing their greatest economic impact. Seventy-six utilities provided data with forty utilities (52%) identifying tree squirrels contacting energized wires/apparatus causing their greatest economic impact. Birds contacting energized wires/apparatus rated the second greatest economic problem with 12 utilities (16%) ranking it as their greatest problem and another 11 utilities ranking it as their second greatest problem. Other mammals contacting energized wires/apparatus were rated as the third greatest economic problem with three utilities (4%) ranking it as their greatest problem, 13 utilities ranking it as their second greatest problem and another 10 utilities ranking it as their third greatest problem. Table 2-10 ranks historic problems, with 1 being the most problematic.

Table 2-10. Economic Impact of Distribution Overhead Problems.

Distribution Overhead Problems	Utility Ranking
Tree squirrels contacting energized wires/apparatus	1
Birds contacting energized wires/apparatus	2
Other mammals contacting energized wires/apparatus	3
Flocks of small birds causing excessive sag and/or conductor jumping/swinging	4
Large mammals rubbing poles and/or guy wires	5
Birds-of-prey contacting energized wires/apparatus	6
Woodpeckers causing structural failure	7
Bird-of-prey nests on distribution lines	8
Other bird nests on distribution lines	9
Fecal contamination flashovers caused by birds	10
Insects on gapped arresters	11
Snakes climbing poles and contacting energized wires/apparatus	12

Each utility also identified specific animals causing the greatest duration and frequency of all their overhead distribution animal-caused outages. Eighty utilities report distribution overhead outage duration is apportioned between mammals (60%), birds (36%), and reptiles (4%). The most problematic mammals are tree squirrels and raccoons (Figure 2-9). Thirty-four utilities (43%) indicate tree squirrels are responsible for their greatest duration of all animal-caused overhead outages; raccoons are listed by another eight utilities (10%). Birds are responsible for the second greatest duration of all distribution overhead outages. Although pigeons, blackbirds, raptors, and starlings are listed as problem species, most utilities (20%) simply report bird outages are primarily caused by unknown bird species.

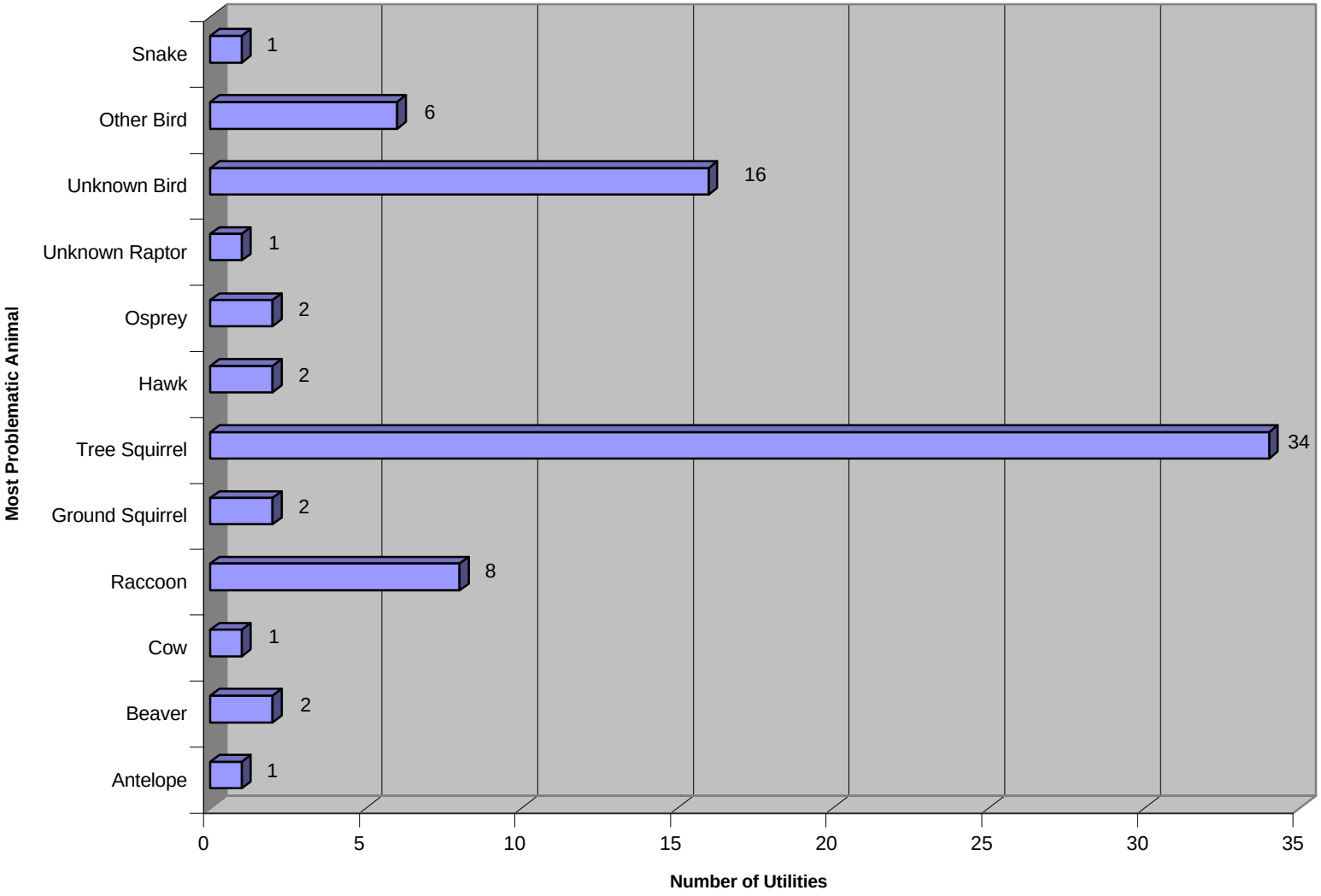


Figure 2-9. Animals Causing the Greatest Duration of Overhead Outages.

The outage frequency results are similar. Eighty utilities report outage frequency is apportioned between mammals (64%) and birds (36%). The most problematic mammals are again tree squirrels and raccoons (Figure 2-10). Thirty-eight utilities (48%) indicate tree squirrels are responsible for the greatest frequency of all animal-caused overhead outages; raccoons are listed by another five utilities (6%). Birds are responsible for the second greatest frequency of all distribution overhead outages. Twenty utilities (25%) report most bird outages are caused by unknown bird species.

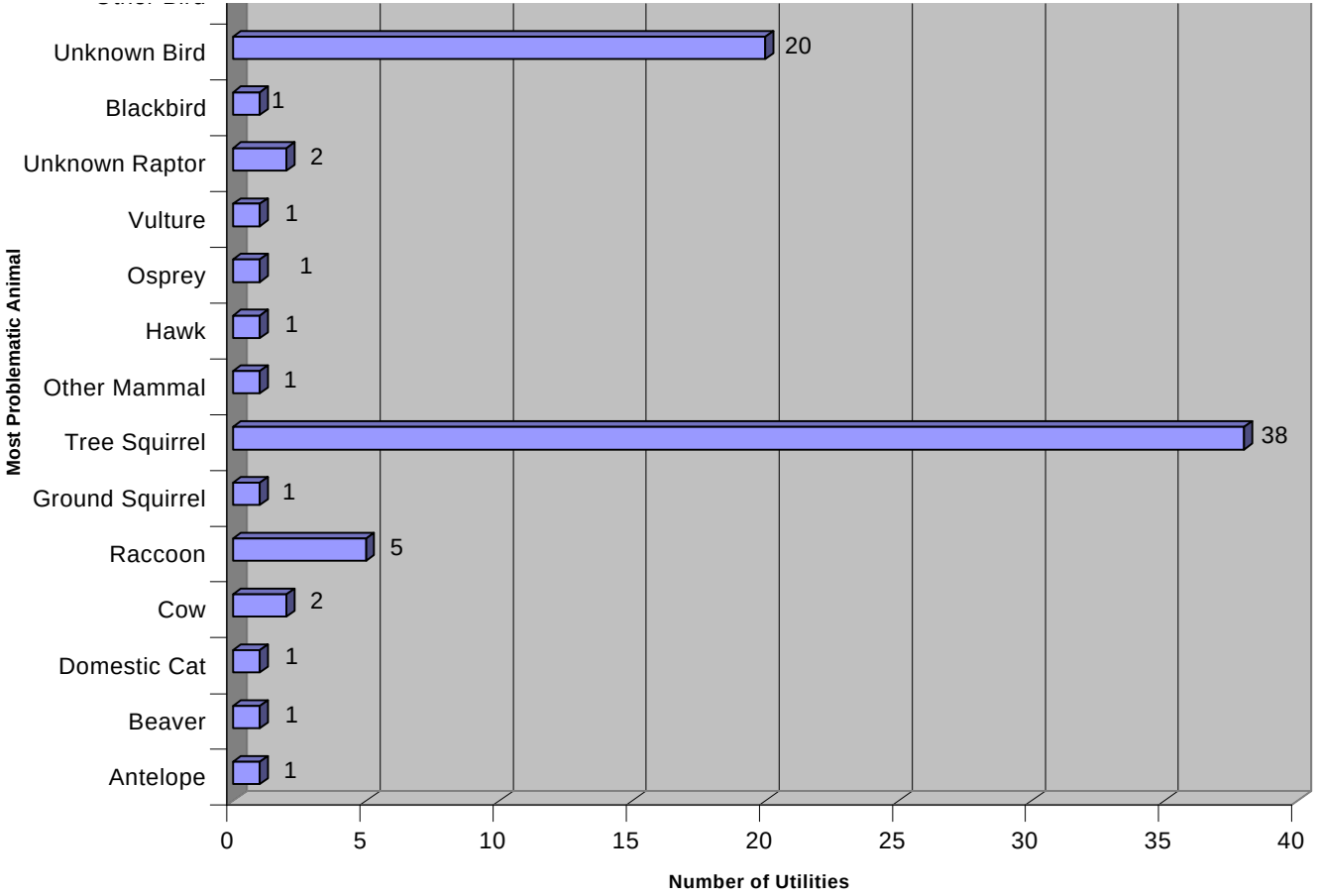


Figure 2-10. Animals Causing the Greatest Frequency of Overhead Outages for Each Utility.

Some utility equipment are more susceptible to animal-caused damage and outages. Utilities were provided a list of common distribution items and asked to rank their top five animal-caused outage duration and frequency problem items. The number of utilities listing a particular piece of equipment as one of their top five problems are tabulated and listed in Table 2-11.

Table 2-11. Distribution Overhead Items Associated with Animal-Caused Outages.

Distribution Overhead Items Associated with Animal-Caused Outages	Number of Utilities Listing Item as a Top Five Problem Outage Duration	Number of Utilities Listing Item as a Top Five Problem Outage Frequency
Power transformers	39	31
Cutouts	28	21
Surge arresters	26	22
Jumper wires contacts	24	23
Phase-to-neutral contacts	23	24
Reclosers	23	22
Potheads at riser locations	18	14
Phase-to-phase conductor contacts	14	14
Pole-top ground wires	10	9
Grounded pole-top hardware	7	7
Regulators	8	7
Breakers	8	5
Switchgear	6	5
Insulator contamination	6	5
Capacitors	5	4
Sectionalizers	5	3
Conductor jumping	3	4
Structural Failure	3	2
Unknown	2	2

Transformers are identified with most outages in terms of both frequency and duration. Equipment poles (e.g. transformers, reclosers) are problematic because of their exposed bushing contacts and because they include other problematic devices such as cutouts, surge arresters, and uninsulated jumper wires (Photo 2-7).

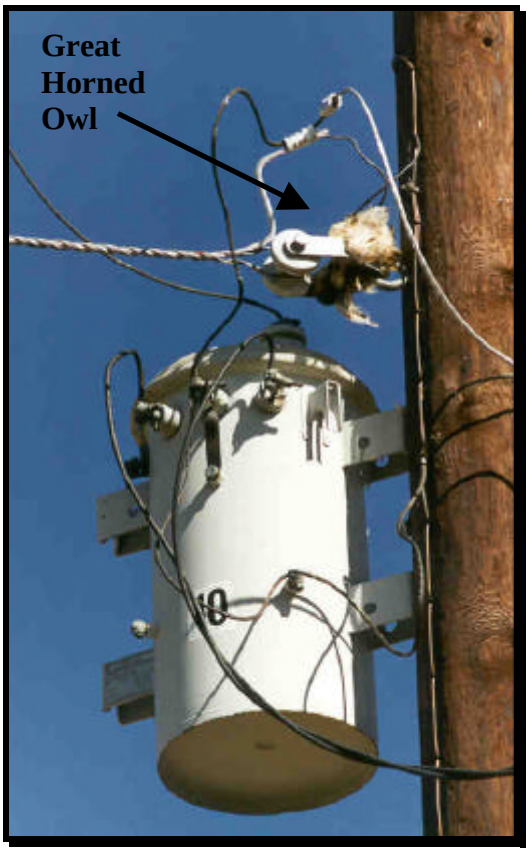


Photo 2-7. Great Horned Owl Electrocution Caused by a Single-Phase Distribution Transformer.

Utilities estimated the percent consumer interruption time for each problem item listed in the previous table. Table 2-12 lists the estimated percent consumer interruption time for the top six problem items as an average. Table 2-12 also lists the number of utilities providing estimates. Utilities rate transformer outages as their primary overhead distribution problem with 13 utilities estimating transformer outages account for 57% of their total annual overhead distribution animal-caused consumer interruption time.

Table 2-12. Estimated Percent Consumer Interruption Time for the Top Six Distribution Overhead Items Associated with Distribution Overhead Animal-Caused Outages.

Items Associated with Animal-Caused Outages	Estimated Consumer Interruption Time	Number of Utilities
Power transformers	57%	13
Cutouts	16%	9
Surge arresters	20%	10
Jumper wires contacts	13%	10
Phase-to-neutral contacts	20%	10
Reclosers	13%	5

Table 2-13 lists the top six distribution overhead items associated with animal-caused outages followed by the most common three animals identified with a particular equipment outage. The number of utilities identifying a specific animal is also provided. Tree squirrels are most often associated with five of the six common distribution overhead problem items.

Table 2-13. Animals Associated with the Top Six Distribution Overhead Items Associated with Animal-Caused Outages.

Items Associated with Animal-Caused Outages	Most Common Animals and Number of Reporting Utilities
Power transformers	**Mammals – 46:** Tree Squirrels (21), Raccoons (14), Ground Squirrels (5), Other (6) **Birds – 22:** Unknown (8), Hawks (3), Blackbirds (2) , Other (9)
Cutouts	**Mammals – 18:** Tree Squirrels (10), Raccoons (3), Ground Squirrels (2), Cats (2), Other (1) **Birds – 16:** Unknown (4), Blackbirds (4), Hawks (3) , Other (5)
Surge arresters	**Mammals – 24:** Tree Squirrels (14), Raccoons (5), Ground Squirrels (2), Cats (2), Other (1) **Birds – 15:** Unknown (8), Blackbirds (2), Owls (2), Other (3)
Jumper wires contacts	**Mammals – 18:** Tree Squirrels (7), Raccoons (4), Cats (3), Other (4) **Birds – 14:** Unknown (5), Blackbirds (3), Hawks (3), Other (3)
Phase-to-neutral contacts	**Mammals – 18:** Tree Squirrels (6), Ground Squirrels (5), Cats (2), Raccoons (2), Other (3) **Birds – 19:** Unknown (7), Eagles (2), Hawks (2), Owls (2), Other (6)
Reclosers	**Mammals – 29:** Tree Squirrels (12), Raccoons (8), Ground Squirrels (4), Other (5) **Birds – 15:** Unknown (7), Hawks (3), Blackbirds (3), Other (2)

Certain overhead distribution circuits may be more prone to animal outages due to configuration, location and habitat, or other factors. Utilities were asked to provide information on the repeated occurrence of overhead distribution outages. Forty-six of 73 utilities (63%) indicate certain distribution overhead circuits have significantly more frequent animal-caused outages than other circuits. Most utilities report certain problem circuits are more prone to outages because of their location and associated habitat (Table 2-14).

Table 2-14. Factors Influencing Increased Distribution Overhead Outages.

Factors Influencing Increased Outages	Number
Location and associated habitat	45
Circuit configuration	6
Other	3
Unsure	0

Table 2-15 lists measures typically employed by utilities to mitigate distribution overhead animal-caused outages. Each utility reviewed the list and graded the effectiveness of each measure applying the following grades:

A. Excellent B. Very Good C. Good D. Poor F. Failed

Utilities also graded their satisfaction with each product's long-term durability. Table 2-15 provides a tabulation of the number of utilities employing each measure and an averaged grade.

Table 2-15. Ranking of Mitigating Measures used on Distribution Overhead Facilities.

Mitigating Measures Employed to Reduce Animal-Caused Outages	No. of Utilities	Grade for Mitigation Success*	Grade for Long-Term Durability*
Insulating Measures			
Wood/Fiberglass Insulated Equipment Mounts	17	B	B
Insulated Bushing Covers	54	B	C
Insulated Jumper/Stinger Wires	47	B	B
Insulated Primary Wire	11	B	B
Heat-Shrink Insulation Material	10	B	B
Insulating Tape	12	B	C
Insulating Paint	2	B	B
Insulating Spray	1	C	C
Insulated Pole Wrapping Mastic	8	C	C
Stirrup Covers	2	B	B
Silicon Insulator Coating to Reduce Bird Contamination Flashovers	3	B	B
Extended Length Deadend Insulators to Provide Additional Clearance	15	B	B
Increased 60" Conductor Separation for Birds-of-prey	21	B	B
Insulated Bird-of-prey Guards	13	B	B
Perching/Nesting Management			
Triangle Perch Guards	13	B	B
Artificial Nesting Platforms	13	B	B
Artificial Elevated Bird Perches	9	B	B
Grounding Solutions			
Eliminating Pole-top Ground Wires	17	B	B
Gapping Pole-top Ground Wires	9	C	C
Ground Wire Molding or Insulated Ground Wires	10	B	C

Mitigating Measures Employed to Reduce Animal-Caused Outages	No. of Utilities	Grade for Mitigation Success*	Grade for Long-Term Durability*
Barriers/Spikes			
Electrostatic Guards	14	B	B
Insulated Disk Barriers	6	C	C
Rotating Tube Barriers for Conductors	4	C	B
Other Type Climbing Guards	8	C	B
Metal Needle Wire Guards/Spikes	7	B	B
Plastic Bird Spikes	7	C	C
Other Mitigating Measures			
Fake Predators (Plastic Owl, Hawk, etc.)	5	C	D

* A = excellent; B = very good; C = good; D = poor; F = failed.

The most common mitigating measure reported by 54 of the 73 utilities is the use of insulated bushing covers (74%) and insulated jumper/stinger covers (64%) (Photo 2-8). Utilities rate bushing covers and insulated jumpers as very good in mitigating animal problems. Utilities rate insulated jumpers as very good in long-term durability, but bushing covers rate lower, as good. Section 2.1 addresses new outage or maintenance problems resulting from retrofitting where several utilities expressed problems with bushing covers (see Table 2-5 in Section 2-1).



Photo 2-8. Insulated Bushing Covers and Cover-up Material on Jumper/Stinger Wires.

The next most commonly listed mitigating measures are designed to reduce bird-of-prey problems (Photo 2-9). These include increased 60-inch conductor separation (29%), insulated

bird-of-prey guards (18%), triangle perch guards (18%), artificial nesting platforms (18%), elevated bird perches (12%), and eliminating pole-top ground wires (23%). Utilities rate all these measures as very good in both mitigating animal problems and long-term durability.

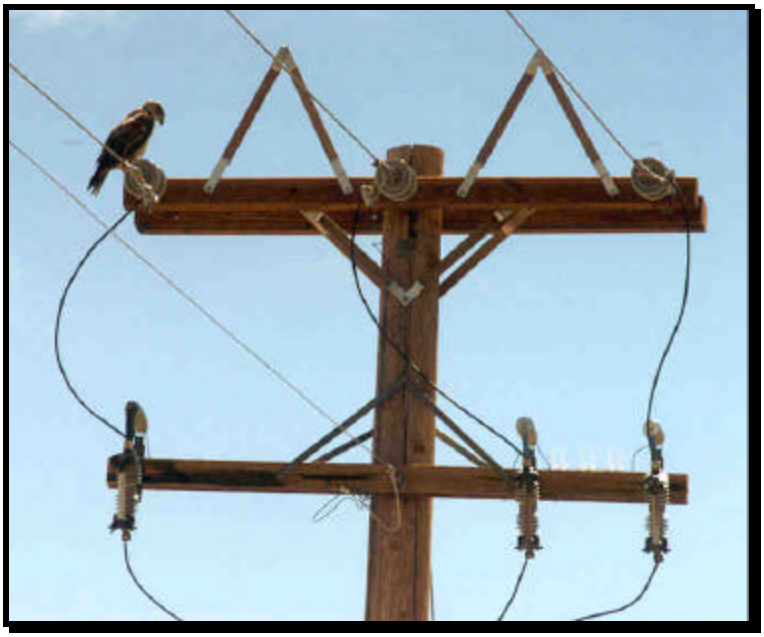


Photo 2-9. Ferruginous Hawk Perching on a Pole Retrofitted with Perch Guards, Insulated Jumper Wires, and Bird Spikes Between Cutout/Arresters.

Most overhead-mitigating measures averaged a ranking of good or very good. Generally there was no dissatisfaction for any one product. Although 15 products were rated as very good in both mitigation success and log-term durability, no product received an overall excellent ranking. Fake predators (e.g. plastic owls, hawk, etc.) received a poor rating for long term durability with one utility reporting squirrels sitting on their plastic owl.

2.1.2 Underground Distribution Animal-Caused Outages

Utilities were provided a list of 13 historic distribution animal problems and asked to identify specific animal-caused underground outage problems causing their greatest economic impact. Fifty utilities provided data with 15 utilities (30%) identifying chewing of underground primary cable as their greatest economic impact. Animals chewing secondary cable rate the second greatest economic problem with five utilities (10%) ranking it as their greatest problem and another 10 ranking it as their second greatest problem. Animals burrowing into underground cabinets and filling them with dirt rates the third greatest economic problem with seven utilities (14%) ranking it as their greatest problem, two utilities ranking it as their second greatest problem and another 11 utilities ranking it as their third greatest problem. Table 2-16 ranks historic problems, with a ranking of 1 being the most problematic.

Table 2-16. Economic Impact of Distribution Underground Problems.

Distribution Underground Problems	Utility Ranking
Chewing UG primary cable	1
Chewing UG secondary cable	2
Burrowing into UG cabinets and filling them with dirt	3
Snakes nesting/living in pad mounted equipment	4
Burrowing into UG cabinets and contacting bare bus work/apparatus	5
Chewing UG service cable	6
Fire ants nesting/living in pad mounted equipment	7
Burrowing into UG cabinets and chewing cable/apparatus	8
Spiders in UG cabinets	9
Wasps in UG cabinets	10
Burrowing into UG cabinets and degrading the foundations	11
Erosion due to animal tunnels	12
Fecal contamination in cabinets	13

Each utility also identified specific animals causing their greatest duration and frequency of underground distribution animal-caused outages. Fifty-five utilities report underground outage duration is apportioned between mammals (76%), reptiles (14%), insects (5%), and miscellaneous other animals (5%). The most problematic mammals are gophers, tree squirrels and snakes (Figure 2-11). Nineteen utilities (35%) indicate gophers are responsible for the greatest duration of all their animal-caused underground outages. Tree squirrels are listed as the most problematic species by nine utilities (16%) and seven utilities (13%) list snakes.

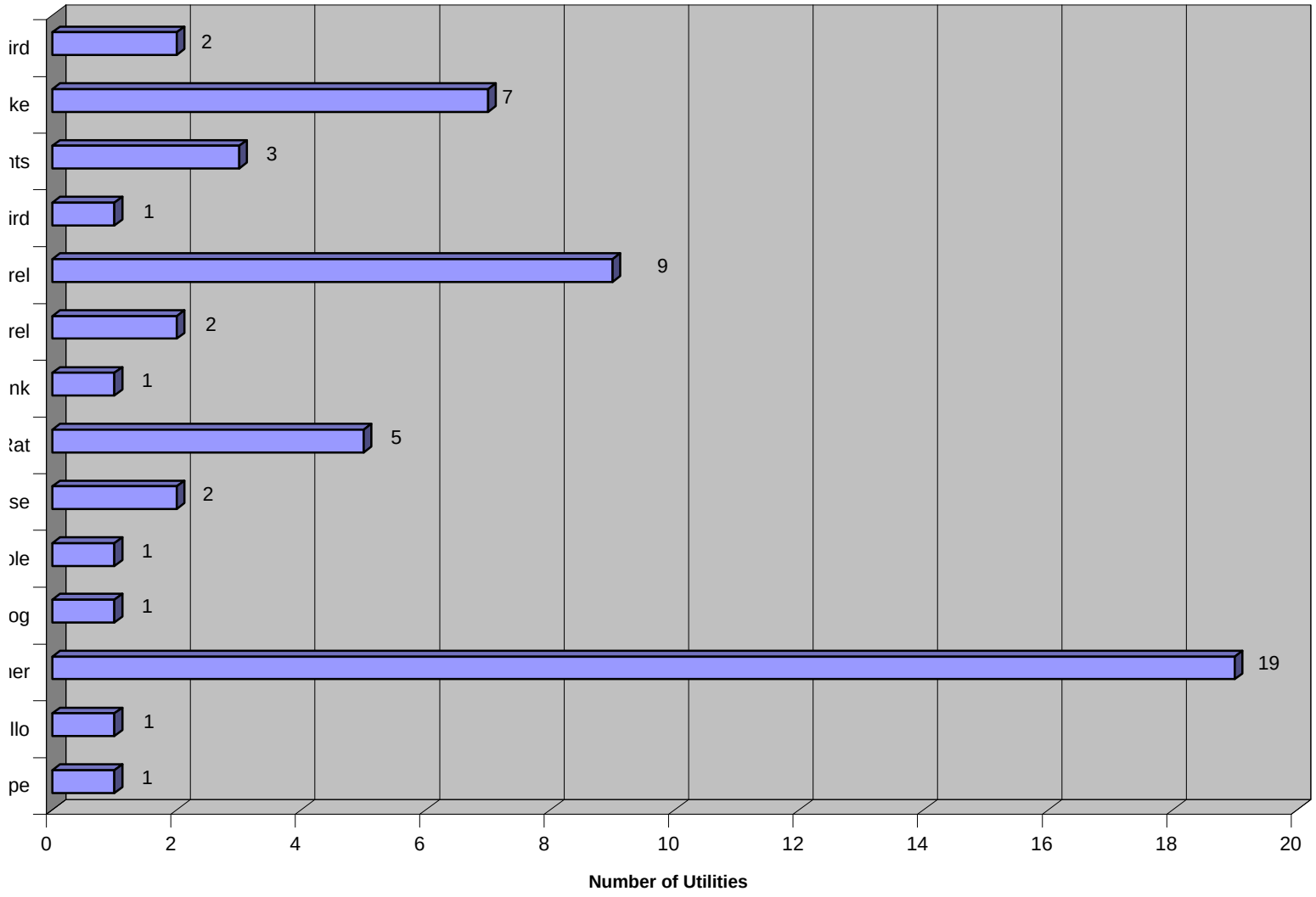


Figure 2-11. Animals Causing the Greatest Duration of Underground Outages.

Fifty-one utilities report outage frequency is apportioned between mammals (76%), reptiles (16%), birds (6%), and insects (2%) .The most problematic mammals are again gophers and tree squirrels (Figure 2-12). Seventeen utilities (33%) indicate gophers are responsible for the greatest frequency of all animal-caused overhead outages; tree squirrels are listed by another 10 utilities (20%). Seven utilities (14%) report snakes are responsible for their greatest frequency of all distribution underground outages.

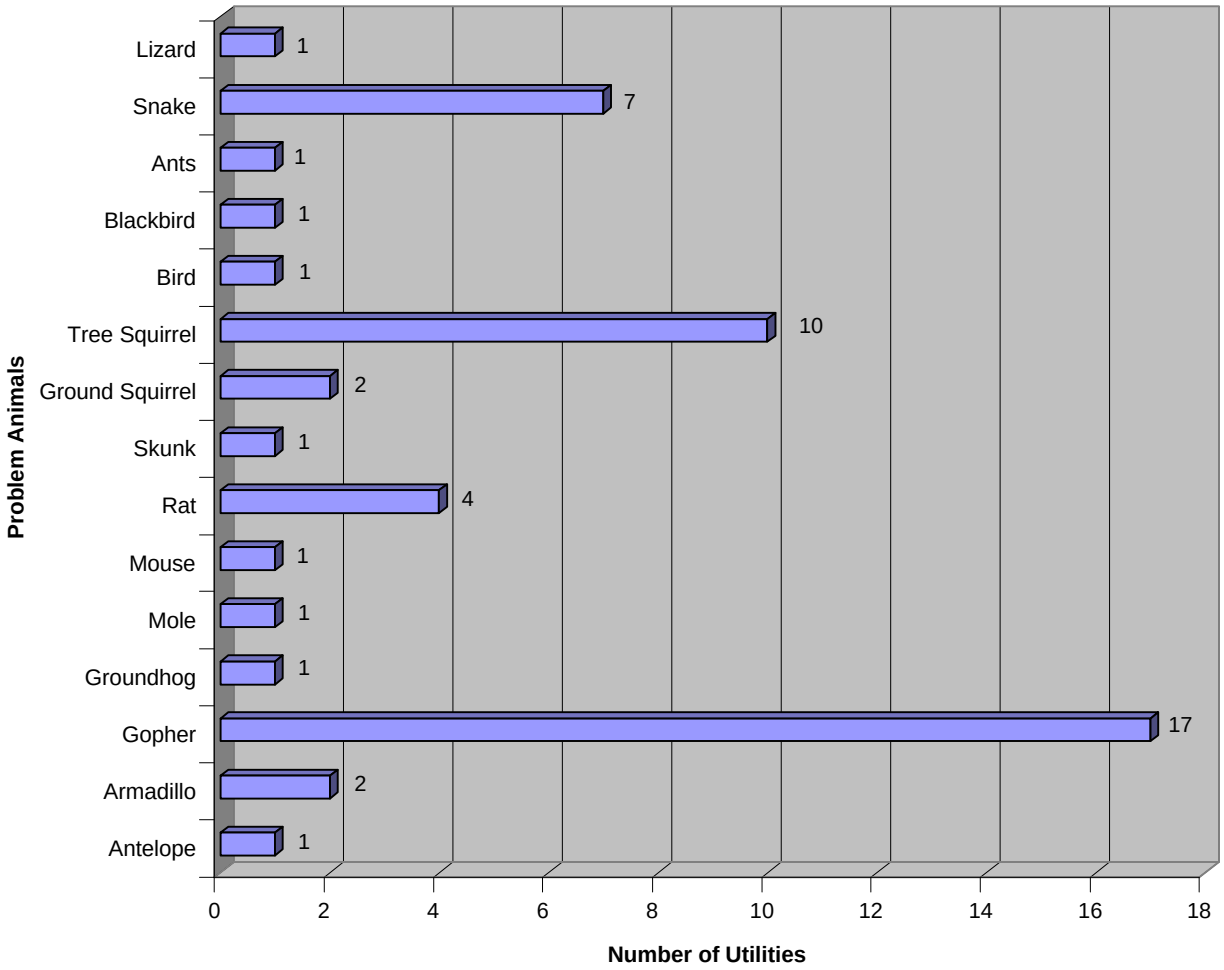


Figure 2-12. Animals Causing the Greatest Frequency of Underground Outages.

Some utility equipment are more susceptible to animal-caused damage and outages. Utilities were provided a list of common underground distribution items and asked to rank their top five animal-caused outage duration and frequency problem items (Table 2-17). The number of utilities listing a particular piece equipment as one of their top five problems are tabulated in Table 2-17. Underground primary and secondary cables are the most problematic items in terms of both customer outage duration and frequency. Other problematic facilities include transformers, bus work, service cable and subsurface/pad mounted switches.

Table 2-17. Distribution Underground Items Associated with Animal-Caused Outages.

Distribution Underground Items Associated with Animal-Caused Outages	Number of Utilities Reporting Top Five Problems Outage Duration	Number of Utilities Reporting Top Five Problems Outage Frequency
UG primary cable	29	23
UG secondary cable	25	22
Subsurface/Pad mounted transformer	15	15
Bus work in pad mounted equipment	12	10
UG service cable	10	10
Subsurface/Pad mounted switch	10	8
UG elbow termination	8	8
Equipment enclosures	7	5
Equipment pads	3	3
Unknown	3	1
Subsurface/Pad mounted sectionalizer	2	0
Other Problems	2	2
Sleeves	1	1
Jumper in pad mounted equipment	0	0
UG ground rod	0	0

Utilities also estimated the percent consumer interruption time for each problem item listed in Table 2-17. Table 2-18 lists the estimated average percent consumer interruption time for the top six problems and the number of utilities providing estimates. Utilities rate underground primary cable faults as their main underground distribution problem with 13 utilities estimating primary cable outages account for 50% of their total annual underground animal-caused consumer interruption time.

Table 2-18. Estimated Percent Consumer Interruption Time for the Top Six Distribution Overhead Items Associated with Underground Animal-Caused Outages.

Items Associated with Animal-Caused Outages	Estimated Percent Consumer Interruption Time	Number of Utilities
UG primary cable	50%	13
UG secondary cable	34%	12
Subsurface/Pad mounted transformer	20%	7
Bus work in pad mounted equipment	19%	10
UG service cable	14%	6
Subsurface/Pad mounted switch	41%	6

Table 2-19 lists the top six distribution underground items associated with animal-caused outages followed by the most common three animals identified with a particular equipment outage. The number of utilities identifying a specific animal is also provided. Gophers are associated with most underground cable problems. Snakes are most often associated with subsurface/pad mounted transformers and bus work in pad-mounted equipment.

Table 2-19. Animals Associated with the Top Six Distribution Underground Problems.

Items Associated with Animal-Caused Outages	Most Common Animals and Number of Reporting Utilities
UG primary cable	Gophers (10), Tree Squirrels (7), Rats (6), Other (14)
UG secondary cable	Gophers (12), Rats (6), Tree Squirrels (4), Other (15)
Subsurface/Pad mounted transformer	Snakes (6), Ants (4), Rats (3), Groundhogs (3), Other (11)
Bus work in pad mounted equipment	Snakes (6), Rats (5), Gophers (3), Other (12)
UG service cable	Snakes (4), Rats (3), Gophers (2), Mice (2), Tree Squirrels (2), Other (3)
Subsurface/Pad mounted switch	Rats (4), Snakes (3), Moles (2), Other (7)

Certain underground distribution circuits may be more prone to animal outages due to location and habitat, or other factors. Utilities were asked to provide information on the repeated occurrence of underground distribution outages. Thirty-three of 57 utilities (58%) indicate certain distribution underground circuits do not have significantly more frequent animal-caused outages than other circuits; nine utilities (16%) are unsure. Only 15 utilities (26%) state certain problem circuits are more prone to outages because of their location and associated habitat (Table 2-20).

Table 2-20. Factors Influencing Increased Distribution Underground Outages.

Factors Influencing Increased Outages	Number
Location and associated habitat	14
Other	3
Unsure	0

Table 2-21 lists measures typically employed by utilities to mitigate distribution underground animal-caused outages. Each utility reviewed the list and graded the effectiveness of each measure applying the following grades:

A. Excellent B. Very Good C. Good D. Poor F. Failed

Utilities also graded their satisfaction with each product's long-term durability. Table 2-21 provides a tabulation of the number of utilities employing each measure and an averaged grade.

Table 2-21. Ranking of Mitigating Measures used on Distribution Underground Facilities.

Mitigating Measures Employed to Reduce Animal-Caused Outages	No. of Utilities	Grade for Mitigation Success*	Grade for Long-Term Durability*
Underground Mitigating Measures			
Pad Mount Ground Sleeves	14	C	B
Buried Cable in Conduit to Deter Rodent Chewing	15	B	B
Metal Mesh Embedded Cable to Deter Rodent Chewing	2	D	C
Duct Sealant	14	B	C
Poison	5	C	D

* A = excellent; B = very good; C = good; D = poor; F = failed.

The most common measures to mitigate underground problems are burying cable in conduit (26%), using duct sealant (25%), and using pad mounted ground sleeves (25%). Utilities report conduit and duct sealant as very good in preventing animal-caused outages (Photo 2-10). Conduit also rates very good in long-term durability; duct sealant rates good. Pad mount ground sleeves rate good in deterring animals and very good in long-term durability. Although sample sizes are low, there is dissatisfaction with the long-term durability of poisons because they must continually be reapplied. This is problematic when facilities are located in remote areas. No underground product received an excellent rating.



Photo 2-10. Underground Cable Placed in Protective Conduit and Slurry.

2.1.3 Distribution Substation Animal-Caused Outages

Each utility was asked to identify specific animals causing their greatest duration and frequency of substation animal-caused outages. Forty-eight utilities report outage duration is apportioned between mammals (48%), birds (29%), and reptiles/amphibians (23%). The most problematic animals are snakes, birds, tree squirrels and raccoons (Figure 2-13). Ten utilities (21%) indicate snakes are responsible for the greatest duration of all their animal-caused substation outages. Unknown bird species caused the greatest outage duration for nine utilities (19%). Tree squirrels are listed as the most problematic species by nine utilities (19%) and seven utilities (16%) list raccoons.

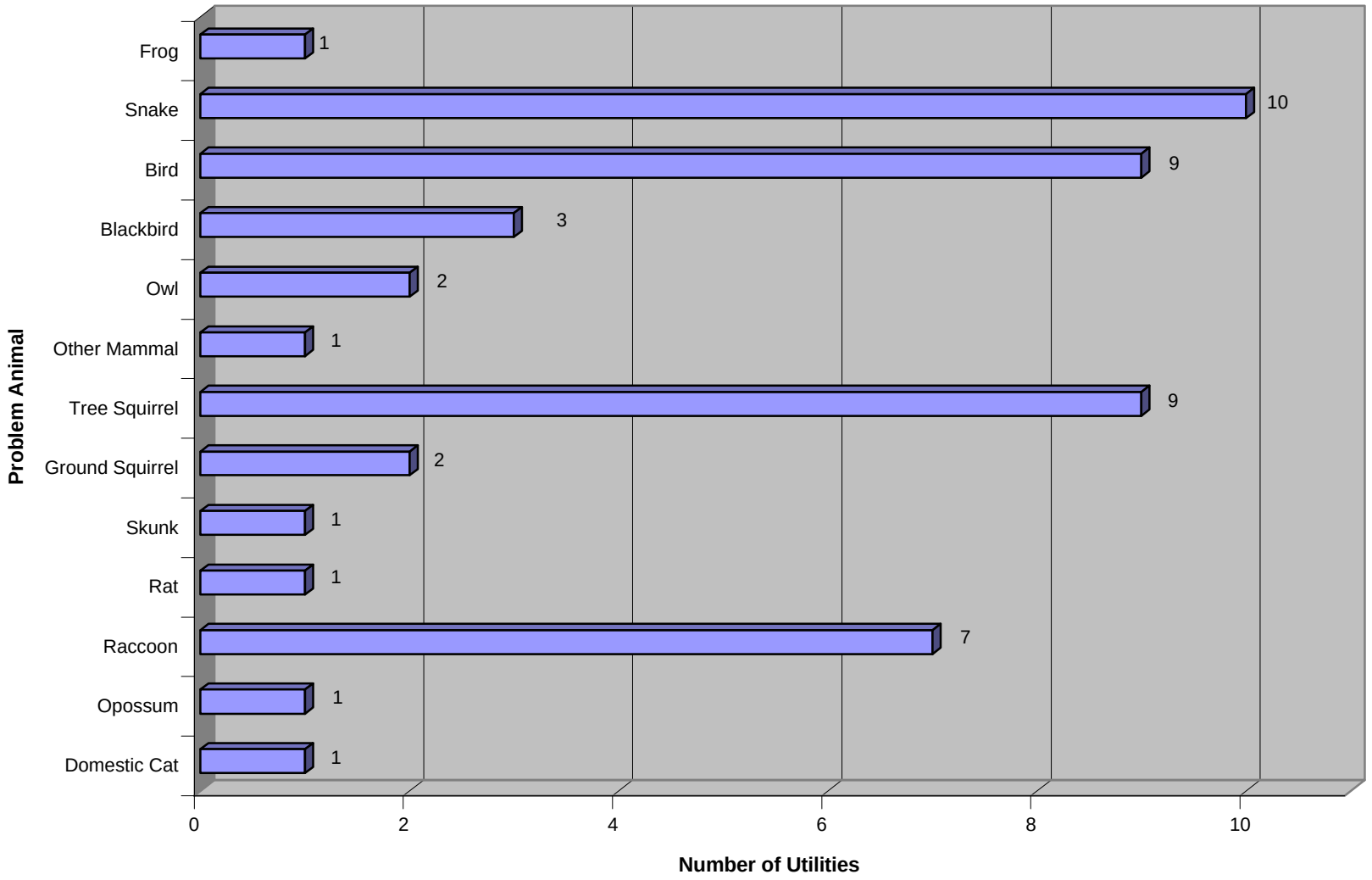


Figure 2-13. Animals Causing the Greatest Duration of Substation Outages.

Substations serve as a focal point for the electric networks they serve. Although substation outages occur less frequently than distribution equipment faults, they often result in greater cost and inconvenience since a single substation serves a large number of consumers. Substation equipment is also often more expensive to purchase and repair. A catastrophic animal failure can result in a ruined transformer plus thousands of dollars for environmental clean-up of spilled oil (Photo 2-11).



Photo by Raychem

Photo 2-11. Substation Transformer Destroyed by a Squirrel

Forty-nine utilities report substation outage frequency is apportioned between mammals (39%), birds (39%), reptiles (20%), and insects (2%). The most problematic animals are birds (Figure 2-14). Fourteen utilities (28%) indicate unknown bird species are responsible for the greatest frequency of all animal-caused overhead outages; snakes are listed by another nine utilities (18%). Eight utilities (16%) state tree squirrels are responsible for the third greatest frequency of all distribution substation outages.

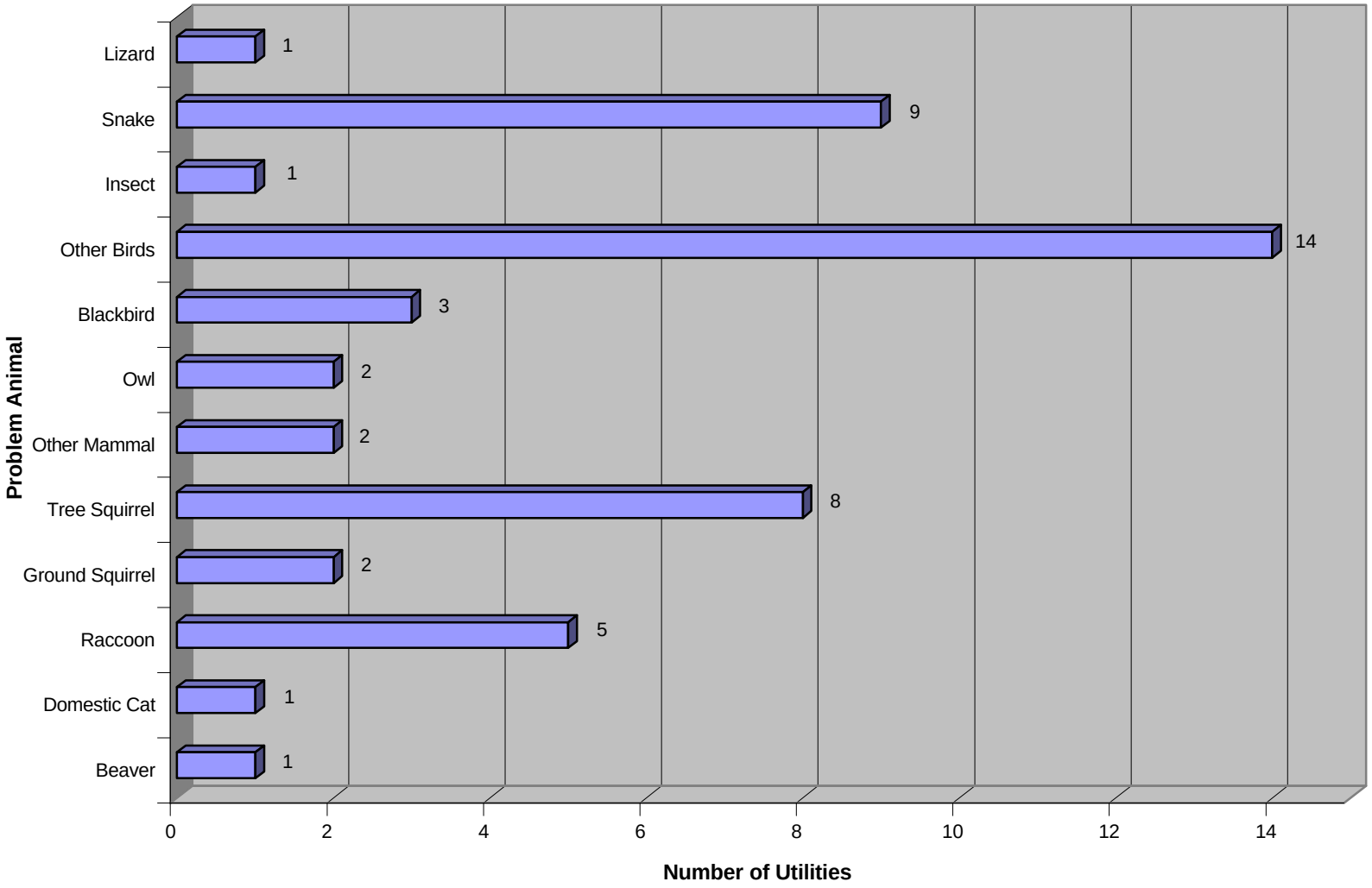


Figure 2-14. Animals Causing the Greatest Frequency of Substation Outages.

Some utility equipment are more susceptible to animal-caused damage and outages. Utilities were provided a list of common substation items and asked to rank their top five animal-caused outage duration and frequency problem items. The number of utilities listing a particular piece of equipment as one of their top five problems are tabulated and listed in Table 2-22. Power transformers are the most problematic item with 13 of 39 utilities (33%) indicating power transformers (combined low and high side) account for their single-greatest duration and frequency of substation outages. Eight utilities (16%) state transformer low sides are their greatest duration problem; five (10%) the high side. Substation breakers/reclosers (Photo 2-12) and bus conductors are also problematic in terms of both customer outage duration and frequency.

Table 2-22. Substation Items Associated with Animal-Caused Outages.

Substation Items Associated with Animal-Caused Outages	Number of Utilities Reporting Top Five Problems Outage Duration	Number of Utilities Reporting Top Five Problems Outage Frequency
Breaker/Recloser	23	21
Power transformer – low side	20	17
Bus conductor	19	17
Power transformer – high side	14	10
Regulator and by-pass switch	10	9
Surge arrester	8	8
Switchgear	7	7
Pothead	6	3
Voltage and current transformers	5	5
Capacitor	5	3
Jumper Wires	5	3
Control wiring	4	4
Insulator contamination	3	3

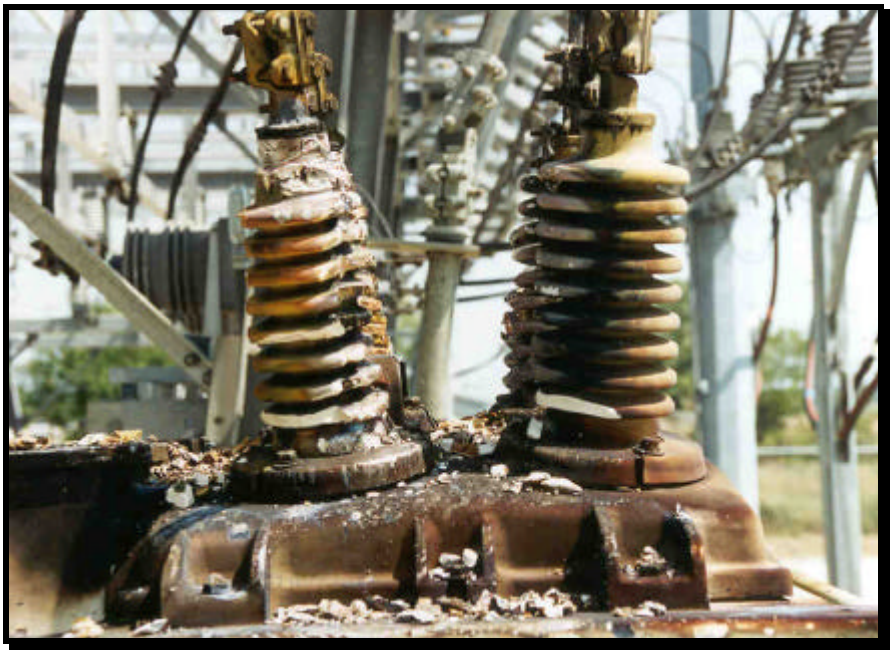


Photo by Carroll Electric Co-Op Corporation

Photo 2-12. Substation Recloser Damage Caused by a Tree Squirrel.

Utilities estimated the percent consumer interruption time for each problem item listed in Table 20-22. Table 2-23 lists the estimated average percent consumer interruption time for the top five problems and the number of utilities providing estimates. Utilities rate breakers/reclosers as their main substation problem with 12 utilities (25%) estimating breaker/recloser outages account for 44% of their total annual animal-caused consumer interruption time.

Table 2-23. Estimated Percent Consumer Interruption Time for the Top Five Substation Items Associated with Animal-Caused Outages.

Items Associated with Animal-Caused Outages	Estimated Percent Consumer Interruption Time	Number of Utilities
Breaker/Recloser	44%	12
Power transformer – low side	18%	8
Bus conductor	27%	10
Power transformer – high side	11%	6
Regulator and by-pass switch	10%	4

Table 2-24 lists the top five substation items associated with animal-caused outages followed by the most common three animals identified with a particular equipment outage. The number of utilities identifying a specific animal is also provided. Mammals are associated with most breaker/recloser, power transformer, and bus contacts. Tree squirrels, raccoons, and house cats cause most mammal problems. Birds are associated with most regulator and by-pass switch outages, followed closely by snakes.

Table 2-24. Animals Associated with the Top Five Substation Items Associated with Substation Problems.

Items Associated with Animal-Caused Outages	Most Common Animals and Number of Reporting Utilities
Breaker/Recloser	**Mammals – 25:** Tree Squirrels (6), Raccoons (6), Cats (5), Other (8) **Birds – 16:** Unknown (12), Blackbirds (2), Owls (2) **Snakes - 4**
Power transformer – low side	**Mammals – 28:** Raccoons (8), Tree Squirrels (5), Cats (4), Other (11) **Birds – 8:** Unknown (7), Hawks (1) **Snakes - 3**
Bus conductor	**Mammals – 22:** Tree Squirrels (9), Raccoons (5), Opossum (2), Other (6) **Birds – 13:** Unknown (11), Blackbirds (1), Hawk (1) **Snakes - 2**
Power transformer – high side	**Mammals – 13:** Tree Squirrels (4), Raccoons (4), Cats (2), Other (3) **Birds – 5:** Unknown (4), Blackbirds (1) **Snakes - 2**
Regulator and by-pass switch	**Mammals – 4:** Tree Squirrels (2), Ground Squirrels (1), Raccoons (1) **Birds – 6:** Unknown (2), Blackbirds (2), Owls (2) **Snakes - 5**

Substations usually contain non-energized metal structures supporting energized electrical equipment. These metal support structures are grounded according to National Electric Safety Code (NESC). Substation electrocutions can occur when and animal climbs on a grounded support structure and contacts an energized surface. Electrocutions also occur when an animal spans two energized conductors. The separation between energized and non-energized surfaces are specified by the NESC. Because higher voltages require greater separation, the substation high side requires greater clearances. Utilities were asked to provide data on substation electrocutions to determine if these greater clearances help prevent animal-caused outages. Thirty surveyed utilities provided data on the percentage of outages occurring on substation low and high sides. Outages on the low substation side average 84%, outages on the high side average 16%.

Certain substations may be more prone to animal outages due to substation configuration, location and habitat or other factors. Utilities were asked to provide information on the repeated occurrence of substation outages. Twenty-eight of 56 utilities (50%) indicate certain substations have significantly more frequent animal-caused outages than other substations. Fifteen of these utilities (54%) state problem substations are more prone to outages because of their location and associated habitat (Table 2-25). One utility states only 186 of their 688 substations (27%) have experienced an animal-caused outage within the past 10 years. Of these, 15 substations (2%) are responsible for 26% of all their substation outages and are more prone due to their location and

associated habitat. These substation outages cost the utility an average of $15,000 each in 1997; excluding overhead and indirect costs.

Table 2-25. Factors Influencing Increased Substation Outages.

Factor Influencing Increased Substation Outages	Number
Location and associated habitat	15
Substation configuration	8
Other	2
Unsure	3

One utility reports increased outages for substations constructed in locations supporting a greater number and diversity of animals. These areas include agricultural, rural areas, and sites located in and near wooded areas. Another utility indicates their raccoon-caused outages are frequently associated with substations located near water or wetlands. Areas with heavy tree density are identified as having more squirrel problems. One utility states animal problems increase after new development destroys habitat and animals emigrated from the disturbed area. They noted 83 of their substations experienced 50% more outages when nearby wooded areas came under development. Increasing outages due to seasonal animal migrations were also noted.

Some utilities state older substations are more prone to outages. Many older substations have numerous cavities providing nesting places for birds. The availability of young birds and eggs in substations attracts other problem animals such as owls and raccoons. Photo 2-13 depicts an outage that occurred when a raccoon raided a Magpie nest and contacted the energized jumpers. When substations are located in areas with few available trees, bird nesting can also be problematic (Photo 2-14). These nests can attract other problem animals such as snakes and raccoons. Accordingly, 35 of 58 utilities (60%) state they have a regular bird nest removal program. Removing active or inactive migrating bird nests requires U.S. Fish and Wildlife Service depredation permits.



Photo 2-13. Magpie Nest on a Three-Phase Transformer Bank.

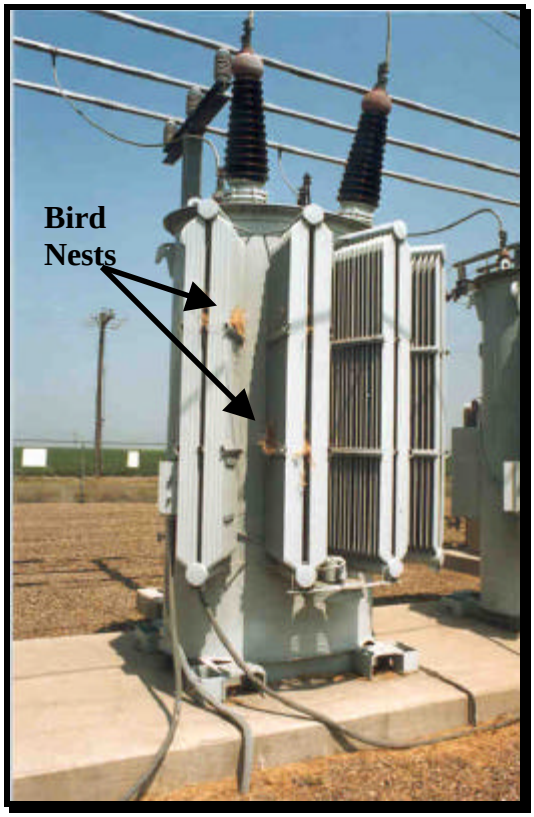


Photo 2-14. Birds Nesting in Substation Transformers.

Table 2-26 lists measures typically employed by utilities to mitigate substation animal-caused outages. Each utility reviewed the list and graded the effectiveness of each measure applying the following grades:

A. Excellent B. Very Good C. Good D. Poor F. Failed

Utilities also graded their satisfaction with each product's long-term durability. Table 2-26 provides a tabulation of the number of utilities employing each measure and an averaged grade.

Table 2-26. Ranking of Mitigating Measures Used on Substation Facilities.

Mitigating Measures Employed to Reduce Animal-Caused Outages in Substations	No. of Utilities	Grade for Mitigation Success*	Grade for Long-Term Durability*
Insulating Measures			
Wood/Fiberglass Insulated Equipment Mounts	4	B	B
Insulated Bushing Covers	32	B	B
Insulated Jumper/Stinger Wires	24	B	B
Insulated Primary Wire	7	A	A
Heat-Shrink Insulation Material	15	B	B
Insulating Tape	13	B	B
Insulating Paint	6	C	C
Insulating Spray	2	F	F
Insulated Pole Wrapping Mastic	2	C	C
Stirrup Covers	2	C	B
Silicon Insulator Coating to Reduce Bird Contamination Flashovers	2	A	A
Extended Length Deadend Insulators to Provide Additional Clearance	5	B	B
Barriers/Spikes			
Electrostatic Guards	3	B	B
Insulated Disk Barriers	1	A	
Rotating Tube Barriers for Conductors	3	B	B
Other Type Climbing Guards	1	C	C
Metal Needle Wire Guards/Spikes	2	C	B
Plastic Bird Spikes	2	C	C

Mitigating Measures Employed to Reduce Animal-Caused Outages in Substations	No. of Utilities	Grade for Mitigation Success*	Grade for Long-Term Durability*
Substation Mitigating Measures			
Regular Substation Perimeter Vegetation Trimming	33	B	C
Regular Substation Bird Nest Removal	40	B	C
Burying Fence Fabric into Substation Trap Rock	11	C	C
Substation Snake Fences	8	B	C
Small-mesh Substation Screening	6	C	C
Electric Fences	3	C	C
Other Fence Modifications	4	B	B
Underground Mitigating Measures			
Pad Mount Ground Sleeves	8	B	B
Buried Cable in Conduit to Deter Rodent Chewing	14	B	B
Metal Mesh Embedded Cable to Deter Rodent Chewing	2	B	B
Duct Sealant	14	C	C
Other Mitigating Measures			
Sonic Distress or Alarm Calls	4	C	D
Ultrasonic Pest Repeller	10	D	D
Strobe Light Animal Deterrent	2	F	D
Grease and Gel Coatings	1	F	F
Nets to Deter Bird Nesting/Roosting	4	C	D
Fake Predators (Plastic Owl, Hawk, etc.)	17	C	D
Iridescent Foil Visual Deterrents	1	C	D
Odor Type Repellent	2	C	C
Taste Type Repellent	2	B	B
Poison	6	B	C
Trapping	3	C	D

* A = excellent; B = very good; C = good; D = poor; F = failed.

The most common substation mitigating measures reported by 40 of 56 utilities are regular substation bird nest removal (71%) and regular substation perimeter vegetation trimming (59%). Utilities rate mitigation success as very good and long-term durability as good. The use of insulating methods is also common with utilities using insulated bushing covers (57%), insulated jumper/stinger covers (43%), heat-shrink insulation material (27%), and insulating tape (23%) (Photo 2-15). All these methods rate very good in effectiveness and durability. Insulated primary wire (13%) rates as excellent in both effectiveness and durability. Insulating paints (11%) and sprays (4%) were used less frequently and had lower rankings.

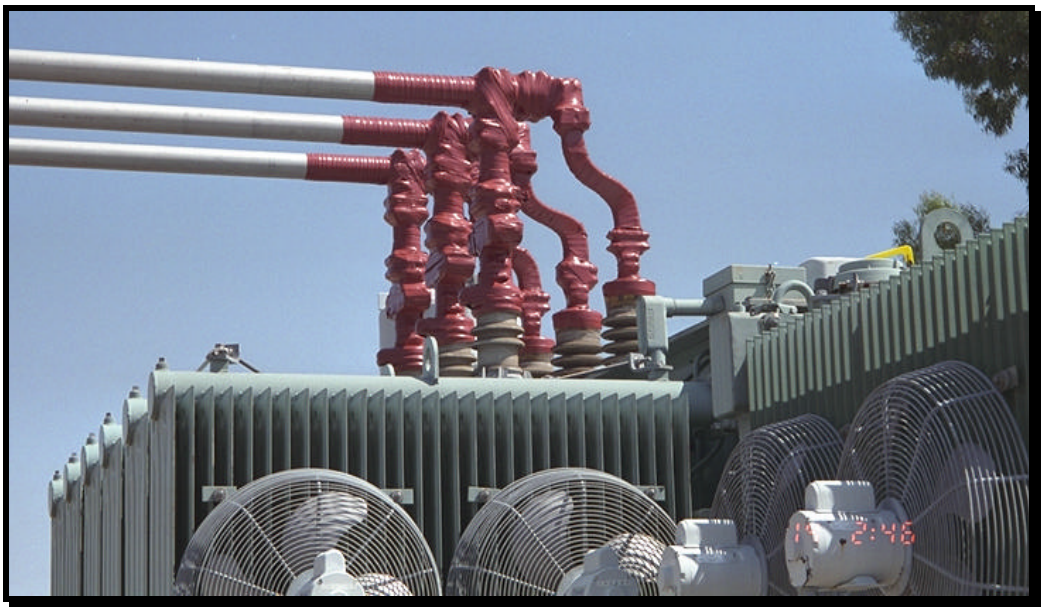


Photo by Raychem

Photo 2-15. Retrofitted Transformer Using Heat-Shrink Products.

A variety of barriers and spikes are listed with success and durability ranging from good to very good. Insulated disk barriers are rated excellent for success by one utility (Photo 2-16). Substation fence modifications (e.g. small-mesh screening, burying fence fabric, snake fences, and electric fences) also rate good to very good in success and durability.

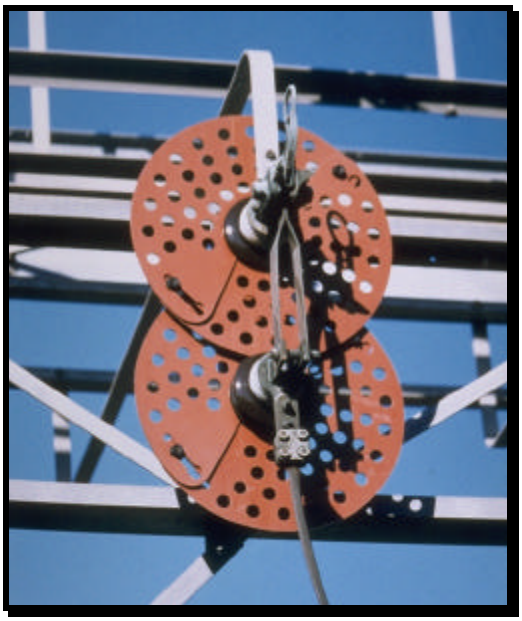


Photo by Raychem

Photo 2-16. Substation Switch Barrier to Prevent Phase to Ground Animal Contacts.

The most common measures to mitigate substation underground problems are burying cable in conduit (25%), using duct sealant (25%), and pad mounted ground sleeves (14%). Utilities report conduit, pad mount ground sleeves, and metal mesh as very good in preventing animal-caused outages and durability. Duct sealant rates good in deterring animals and long-term durability.

Sonic distress calls (7%), fake predators (30%), iridescent foil visual deterrents (2%) all rate good in success but poor in long-term durability. Ultrasonic pest repellers (18%) rate poor in both mitigation success and durability. Strobe light animal deterrents were used by two utilities and failed to deter animals. Although some of these products initially have limited success, animals soon become acclimated to these devices and return.

3. MANUFACTURERS SURVEYS

3.1 Original Equipment Manufacturer Survey – Survey A

In December 1998 a survey was mailed to 174 original equipment manufacturers (OEM's). Data were sought on the types of products produced and the cost and difficulty to animal proof these products. Information was also sought on how companies communicate with utilities and respond to requests for new products. Sixteen companies (9%) responded to the survey and provided information on 37 different products. The original survey is identified as Survey A and is provided in Appendix A.

3.1.1 OEM Product Information

Sixteen original equipment manufactures provided information on 37 diverse electric utility products they either manufacture, sell, or distribute to the electric utility industry (Table 3-1).

Table 3-1. Original Equipment Manufacturer Products

Overhead Products	Underground Products
Transformer	Padmount Transformer
Sectionalizer	Vault Transformer
Primary Conductor	Primary Cable
Arrester	Secondary Cable
Insulator	Fiberglass Conduit
Jumper	Switch
Switch	Termination
Pole	Enclosure
Breaker Monitor	
Pole Hardware	
Crossarm	

Each OEM was asked to identify products offering animal-proof options and the species the options are designed to control plus the percent cost increase. Only five manufacturers (31%) indicate specific animal options are available for their products. These products are designed to control a variety of animals and increase product costs up to 10% (Table 3-2).

Table 3-2. Animal-Proof Options, Species Controlled and Percent Cost Increase

Product Description	Animal Option	Animals Controlled	Cost Increase
Transformer	Bushing Cover	All climbing mammals and birds	2%
Arrester	Cover	Squirrels and birds	10%
Padmount transformer	Deadfront	Snakes and insects	5%
Underground switch	Deadfront		0%
Underground enclosure	Cover-up Tubing	Snakes and mice	1%

Each manufacturer was asked if they had ever been approached by utilities to provide animal-proofing options. Twelve OEMs (75%) have never received any requests for additional animal proofing. Four companies (25%) report a total of five utility requests for product modifications and/or enhancements. Four requests were fulfilled and customers were either very satisfied or extremely satisfied. One request was not fulfilled because the customer lost interest in the product. Six manufacturers (38%) also state they give serious consideration to minimizing the potential for animal-caused outages when developing any new products (Figure 3-1).

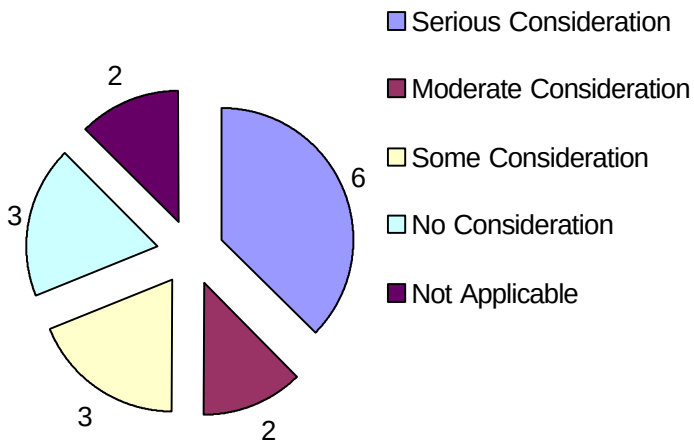


Figure 3-1. Consideration Given to Minimizing Potential Animal-Caused Outages when Developing New Products.

3.1.2 OEM Product Marketing

Each manufacturing company was asked to review factors they believe cause utilities to install animal deterrents on electric systems. They were asked to review each factor and rate the importance they *perceive* a utility gives each when deciding to implement animal mitigating measures. Table 3-3 lists ranked factors for 15 responses. In general, OEM's perceive a higher utility priority on direct utility losses such as lost revenue and damaged equipment, than on consumer reliability issues such as consumer complaints and inconvenience to consumers. Most manufacturers (53%) said they believe lost utility revenue is a very important factor triggering utilities to install animal deterrents, followed by damaged equipment costs. The utility survey also asked utilities to review and rank these same factors (see Section 2.1, Table 2-1). The utility responses demonstrate a greater emphasis on outage frequency and consumer complaints and less concern regarding lost utility revenue and damaged equipment.

Table 3-3. Manufacturers' Perception of the Factors Triggering Utilities to Install Animal Deterrents.

Factors Triggering the Installations of Animal Deterrents	Very Important	Moderately Important	Somewhat Important	Not Important
Lost utility revenue	53%	33%	7%	7%
Damaged equipment cost	47%	27%	20%	6%
Liability issues	40%	40%	13%	7%
Outage frequency	40%	33%	20%	7%
Consumer complaints	40%	27%	33%	0%
Outage duration	33%	14%	47%	6%
Power quality	33%	14%	40%	13%
Federal/State environmental laws	20%	33%	33%	14%
Number of affected consumers	13%	60%	27%	0%
Economic impact on consumers	13%	13%	53%	21%
Inconvenience to consumers	7%	20%	53%	20%
Impacts to wildlife species	0%	13%	40%	47%

Utility personnel may not always be aware of new utility products and options available for combating animal-caused outage problems. The OEMs were asked to provide data on how they disseminate product information to the utility industry about their general products and animal-mitigating options. Table 3-4 lists various advertising methods used by the 16 companies to promote products. Trade shows, sales calls, and catalogs are used most frequently to promote general products. Sales calls, trade journals, and trade shows are used more frequently to promote specific animal protection products.

Table 3-4. OEM Advertising Methods.

Advertising Methods	General Products - Percentage Using Method	Animal Products - Percentage Using Method
Trade Shows	88%	31%
Sales Calls	81%	38%
Catalogs	81%	25%
Trade Journals	69%	38%
Word of Mouth	69%	25%
Professional Presentations	69%	19%
Web Site	56%	19%
Product Mailings	56%	19%
Professional Papers	44%	13%
Case Studies	19%	6%
Video Tapes	13%	6%

The manufacturers also provided data on which utility industry personnel groups they target when disseminating product information (Table 3-5). They report advertising is primarily targeted towards standards engineers, engineering and operations management, purchasing agents, and staff engineers. Although environmental staff may also often be involved in solving animal problems, they are targeted less frequently (38%).

Table 3-5. OEM Advertising Target Groups.

Target Group	Percentage Targeted When Manufacturers' Advertise
Standards Engineers	87%
Engineering Management	70%
Operations Management	70%
Purchasing Agents	68%
Staff Engineers	67%
Consultants	44%
General Management	41%
Environmental Staff	38%
Linemen	37%
Technicians	30%
Staking Engineers	26%
Other	25%

3.1.3 OEM Product Development

Companies were asked what, if any, barriers are faced when developing and marketing new animal-caused outage mitigating products. Eight manufacturers cite the following barriers:

- Cost (due to expensive design and testing).
- Poor utility communication describing their animal problems.
- Utility hesitancy to try new products.

3.2 Survey of Manufacturers Producing Animal-caused Outage Mitigating Products – Survey B

In December 1998 a different manufacturing-oriented survey was mailed to 60 companies who manufacture, sell or distribute products specifically designed to protect animals, mitigate outages and/or minimize the probability of damage to electric utility equipment. Data were sought on the types of products available and how these products are tested. Information was also sought on how companies communicate with utilities and respond to requests for new products. Thirteen companies (21%) responded to the survey and provided information on 45 different animal mitigating products. The original survey is identified as Survey B and is provided in Appendix A.

3.2.1 Product Information

The development of outage-mitigating products is an emerging market according to survey responses. Most products (73%) have been on the market for less than 10 years (Figure 3-2) and 21 products (46%) have become available only within the last five years. The companies also state 28 products (62%) have increasing market demand (Figure 3-3). Only two products (4%) have decreasing demand.

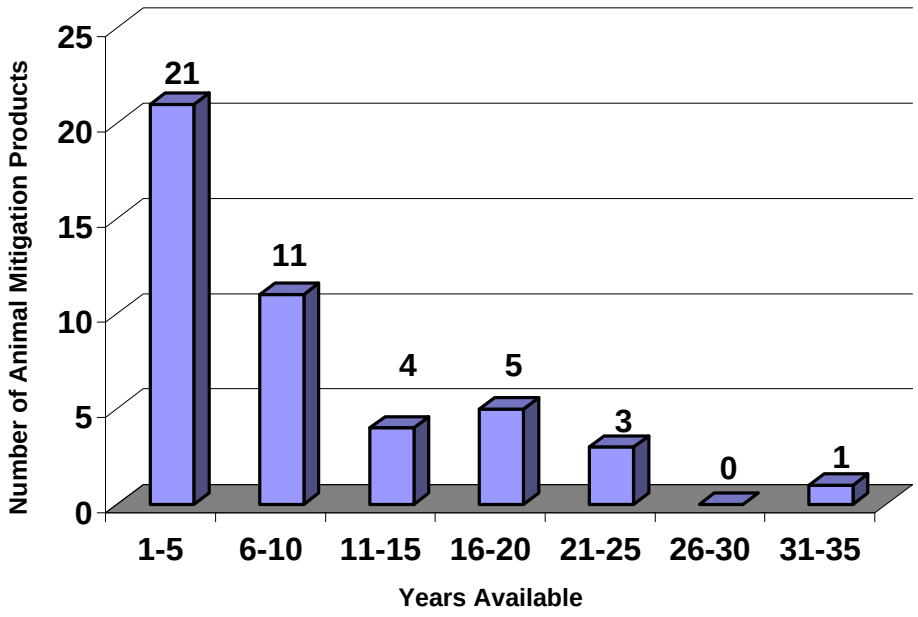


Figure 3-2. Years Outage Mitigating Products Have Been Available.

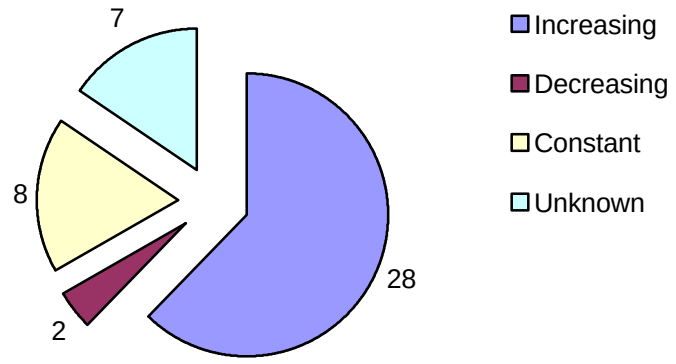


Figure 3-3. Product Demand

Manufacturers state a willingness to work with utilities to develop new products (Photo 3-1). Five companies report a total of eight utility requests for product modifications and/or enhancements. All requests were fulfilled and customers were either very satisfied or extremely satisfied.

Problem: **Solution:**





Photo 3-1. Kaddas Enterprises is Developing Raptor-Safe Products for Steel Poles.

Although many animal protection products are manufactured to comply with ANSI, IEEE and/or ASTM standard products, there are few developed standards specific to animal protection devices themselves. Each company was asked to provide data on product standards and testing. Only eight of 45 products (18%) are designed subject to an ANSI standard and only two of the products (4%) are RUS-approved. Although few standards exist, 34 products (76%) have been field and/or laboratory tested (Figure 3-4). Published field data are available for 27 products (60%). Warranties ranging from one to five years are also offered for 32 products (71%).

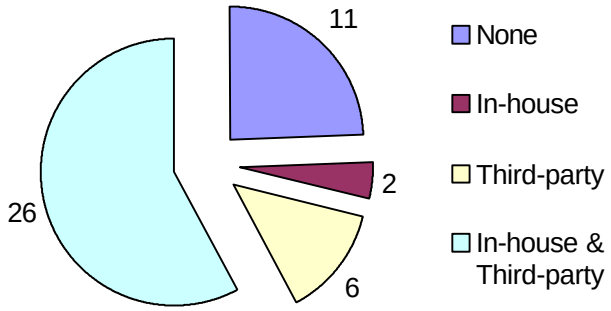


Figure 3-4. Type of Product Testing Performed on 45 Animal Protection Devices.

The 45 outage mitigating products claim to reduce problems with 17 different mammal species and a variety of birds (Figure 3-5). The most commonly listed controlled mammal species are tree squirrels, ground squirrels, raccoons, opossums and rats. Tree squirrels were listed frequently with 20 products available. Bird-control measures primarily target birds-of-prey, blackbirds, gulls and pigeons. Birds-of-prey were listed most frequently with 23 available products.

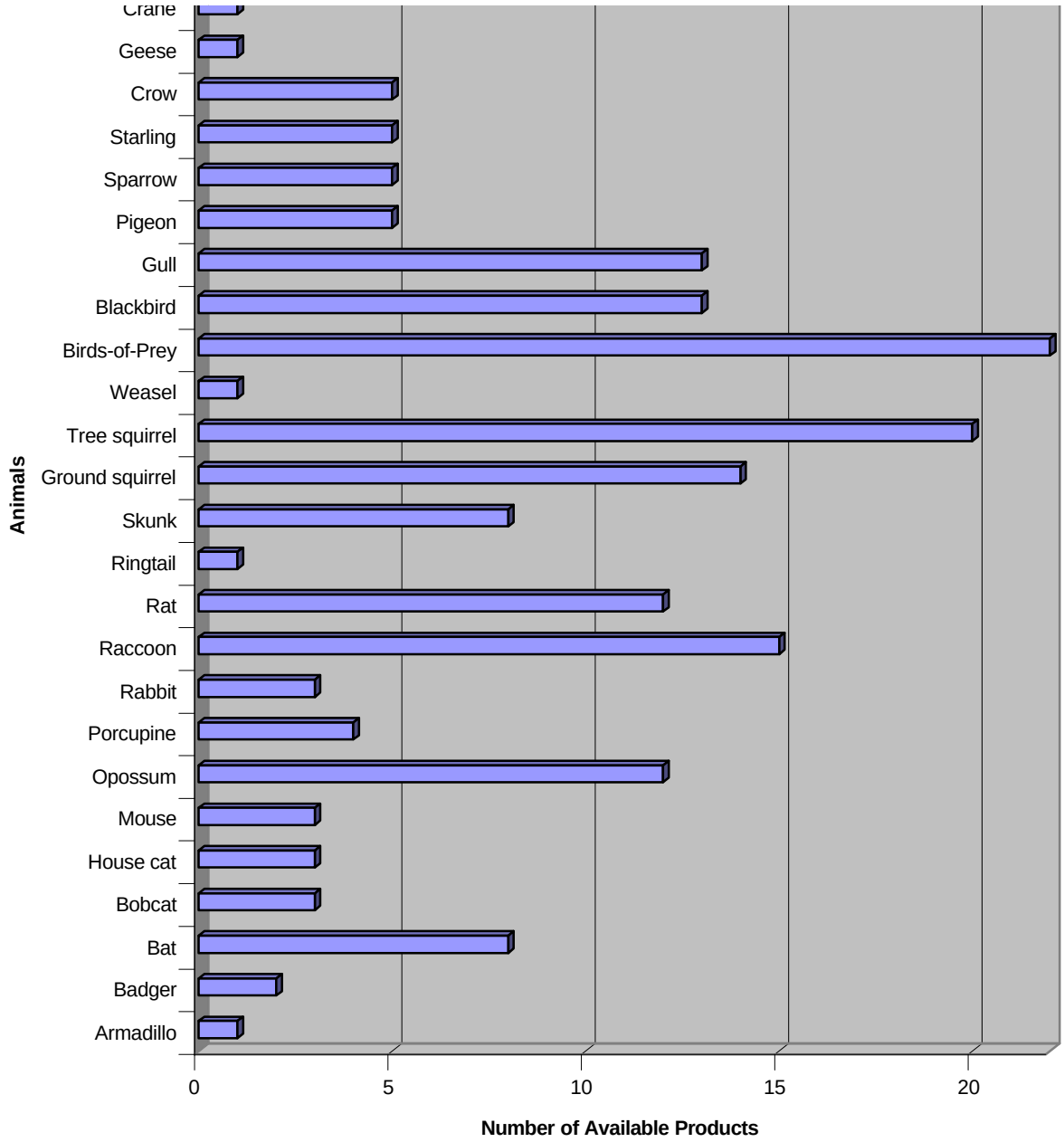


Figure 3-5. Animals and Number of Products Designed to Mitigate Problems.

3.2.2 Product Marketing

Each manufacturing company was asked to review factors they believe cause utilities to install animal deterrents on electric systems. They were asked to review each factor and rate the importance they *perceive* a utility gives each when deciding to implement animal mitigating measures. Table 3-6 lists ranked factors for 13 responses. In general, companies perceive a higher utility priority on direct utility losses such as lost revenue and damaged equipment, than on consumer reliability issues such as consumer complaints and inconvenience to consumers. The OEM's indicated the same perception in the Original Equipment Manufacturer Survey (see Section 3.1.2, Table 3-3). Most manufacturers (69%) said they believe lost utility revenue is a very important factor triggering utilities to install animal deterrents, followed by damaged equipment costs. The utility survey also asked utilities to review and rank these factors (see Section 2.1, Table 2-1). The utility responses demonstrate an emphasis on outage frequency and consumer complaints and less concern for lost utility revenue and damaged equipment.

Table 3-6. Manufacturers' Perception of the Factors Triggering the Installation of Animal Deterrents.

Factors Triggering the Installations of Animal Deterrents	Very Important	Moderately Important	Somewhat Important	Not Important
Lost utility revenue	69%	8%	0%	23%
Damaged equipment cost	61%	23%	8%	8%
Outage duration	55%	22%	8%	15%
Outage frequency	55%	15%	15%	15%
Consumer complaints	38%	32%	15%	15%
Number of affected consumers	23%	55%	0%	22%
Inconvenience to consumers	23%	46%	23%	8%
Federal/State environmental laws	23%	31%	23%	23%
Power quality	23%	31%	15%	31%
Impacts to wildlife species	15%	15%	38%	32%
Liability issues	8%	31%	38%	23%
Economic impact on consumers	8%	31%	31%	30%

Utility personnel may not always be aware of products available for combating animal-caused outage problems. The producers of animal-mitigating products were asked to provide data on how they disseminate product information to the utility industry. Table 3-7 lists various advertising methods used by companies to promote products specifically designed to mitigate animal-caused outages. Catalogs, trade journals, trade shows and word of mouth were listed most frequently. Videotapes, professional papers and presentations and case studies were listed less frequently.

Table 3-7. Advertising Methods.

Advertising Methods	Percentage Using Method
Catalogs	85%
Trade Journals	85%
Trade Shows	85%
Word of Mouth	85%
Web Site	77%
Sales Calls	77%
Product Mailings	77%
Video Tapes	54%
Professional Papers	54%
Professional Presentations	54%
Case Studies	38%

The manufacturers of animal-mitigating products provided data on which utility industry personnel groups they target when disseminating product information (Table 3-8). They report advertising is primarily targeted towards standards engineers, linemen, engineering management and staff engineers. OEM's also primarily target standards engineers (see Section 3.1.2, Table 3-5). Although environmental staff and consultants may also often be involved in solving animal problems, they are targeted less frequently. Purchasing agents responsible for selecting various products were also less targeted, as were staking engineers and technicians.

Table 3-8. Advertising Target Groups.

Target Group	Percentage Targeted When Manufacturers' Advertise
Standards Engineers	82%
Linemen	77%
Engineering Management	75%
Staff Engineers	75%
General Management	70%
Operations Management	68%
Environmental Staff	65%
Purchasing Agents	57%
Consultants	53%
Technicians	50%
Staking Engineers	44%
Other	44%

3.2.3 Addressing Utility Concerns

The manufacturers of animal-caused outage mitigating products must address certain utility concerns when trying to convince utilities to use their products. These companies were provided a list of utility product concerns and asked to identify common issues for the 45 products they distribute (Table 3-9). The respondents state 21 of their products (47%) must commonly address appearance/aesthetics to convince utilities to use their products. Product cost is listed for 19 products (42%).

The companies also ranked general product concerns they perceive to be the most important to electric utilities (Table 3-9). The respondents perceive product effectiveness as the most important factor to utilities, just above product cost and maintenance costs. Product life expectancy, material properties and installation labor costs were perceived as a lower utility importance although six power companies (7%) in the utility survey indicate material properties are very important and utilities desire to see products with improved ultraviolet resistance (see Section 2.1, Table 2-5).

Table 3-9. Utility Concerns Regarding Installation of Animal Deterrents.

Primary Utility Concerns	No. of Products Addressing Utility Concerns	No. of Utilities - "Most Important"	No. of Utilities – "Very Important"	No. of Utilities - "Important"
Product Effectiveness	15	4	2	2
Product Cost	19	3	2	0
Maintenance Costs	8	2	0	3
Long-Term Cost Benefit	14	1	3	0
Appearance/Aesthetics	21	1	0	1
Product Life Expectancy	10	1	1	2
Material Properties	11	0	1	2
Installation Labor Cost	15	0	1	1
Nontoxic to Animals	6	0	1	0
Ease of Use	1	0	1	0

3.2.4 Product Development

Companies were asked what, if any, barriers are faced when developing and marketing new animal-caused outage mitigating products. Eight manufacturers cite the following barriers:

- Cost (due to expensive design and testing)
- Difficult to develop a universal product (due to vast number of utility configurations)
- Utility hesitancy to try new products (especially without name recognition)

Only five companies (38%) have not faced any barriers when developing and marketing new animal-caused outage mitigating products.

4. CONCLUSIONS

4.1 Utility Survey

All utilities that responded in the survey experience animal-caused outages on portions of their system. Accordingly, most (77%) have structured programs to combat animal problems. Although these programs vary in their sophistication, most utilities (65%) feel their programs are effective in controlling animal problems. Thirty-four of 84 utilities (40%) state animal-caused outages are staying constant, 30 utilities (36%) state outages are declining. Outage duration data provided by 33 utilities support this, with the percent of annual animal-caused problems dropping from 7.5% to 7.1% from 1993 through 1997. Outage frequency data provided by 27 utilities were more variable, fluctuating between 7.5% and 9.6%.

Utilities report consumer reliability issues primarily trigger them to install animal deterrents. Over 80% of the utilities state outage frequency and consumer complaints are the most important factors triggering them to install animal deterrents.

Although outages create financial problems for electric utilities, very few utilities (19%) have a structured method to calculate animal-caused outage costs. Additionally, few utilities (22%) perform any cost analysis prior to implementing programs to control animal problems. Annual outage data provide by six utilities for approximately 1.8 million consumers indicate that the average annual animal-outage cost per consumer is approximately $0.39. According to the EEI Pocketbook of Electric Utility Industry Statistics, there were 120 million consumers served by the total electric utility industry in 1996. If the costs in this study are representative of the entire industry, animal problems result in $46,800,000 per year. This estimate is probably low since outage sources classified as “unknown” likely include additional animal problems not accounted for in this estimate.

4.1.1 Distribution Overhead Problems

Most outage duration and frequency problems caused by animals are associated with overhead distribution facilities. Utilities in this study report that approximately 73% of their animal-caused outage time and 79% of their outage events occur on distribution facilities. Tree squirrels contacting energized wires/apparatus cause the greatest animal economic impact for 40 utilities (52%). Birds contacting energized wires/apparatus cause the second greatest animal economic impact for 12 utilities (16%). Utilities report climbing mammals cause most problems in both outage duration (60%) and frequency (64%). Squirrel problems appear to be elevated in the spring due to nesting and during fall as squirrels prepare for winter. Birds also cause problems in both outage duration (36%) and frequency (36%). Bird problems appear to be elevated in the spring due to nesting and during fall migration as large numbers of birds’ concentrate. Most utilities (63%) indicate that certain circuits are more prone to animal problems due to their location and habitat.

The most problematic overhead devices are power transformers. More utilities (39 out of 76) list transformers in their top five list of problems than any other device. They estimate transformer animal outages result in their greatest percentage of outage time (57%) and are most often caused by tree squirrels and raccoons. Cutouts, surge arresters, jumper wire contacts, phase-to-neutral

contacts, and reclosers received similar rankings, with 23 to 28 utilities placing them in their list of top five problem items. Cutouts, jumper wire contacts, and phase-to-neutral problems are more evenly split between mammals (primarily tree squirrels) and birds. Unfortunately, utilities are generally not able to differential bird species and list most problem species as unknown. Surge arrester and recloser problems are primarily caused by tree squirrels and raccoons.

The most common mitigating measure used to combat overhead outages are bushing covers (54 utilities, 74%) and insulated jumper/stinger covers (47 utilities, 64%). Utilities rate covers and insulated jumper/stinger covers as very good in mitigating animal problems. Utilities rate insulated jumpers as very good in long-term durability, but bushing covers rate lower, as good. Six utilities state that they would like to see products such as bushing covers more resistant to ultraviolet degradation and noted tracking problems with deteriorated bushing covers.

Other mitigating measures employed on distribution overhead systems include a variety of insulating measures, barriers/spikes, grounding solutions, and perching/nesting management. In general, most these measures averaged a ranking of either good or very good and there was no dissatisfaction for any product. Although 15 products were rated as very good in both mitigation success and long-term durability, no product received an overall excellent rating. Fake predators (e.g. plastic owls, hawks, etc.) received a poor rating for long-term durability after pest species became habituated.

4.1.2 Distribution Underground Problems

Fewer animal-caused outage duration and frequency problems are associated with underground distribution facilities. Utilities in this study report that approximately 11% of their animal-caused outage time and 7.6% of their outage events occur on underground facilities. Animals chewing underground primary cable cause the greatest animal economic impact for 15 utilities (30%). Animals chewing underground secondary cable cause the second greatest animal economic impact for five utilities (10%). Utilities report mammals cause most underground animal problems in both outage duration (76%) and frequency (76%). Snakes also cause problems in both outage duration (14%) and frequency (16%). Insects are responsible for 5% of outage duration and 2% frequency. Most utilities (58%) indicate that certain circuits do not appear to be more prone to animal problems.

The most problematic underground facilities are underground primary and secondary cable. More utilities (29 out of 50, 58%) list primary cable in their top five list of problems than any other item. Utilities estimate primary cable animal outages result in their greatest percentage of outage time (50%) and are most often caused by gophers. Secondary cable animal outages result in the second greatest percentage of outage time (34%) and are most often caused by gophers. No species differentiation was noted for the 12 different North America gopher species. Subsurface/pad mounted transformers and switches, bus work in pad mounted equipment, and service cable received similar rankings, with 10 to 15 utilities placing them in their list of top five problem items. Snakes and rats are the primary problem associated with these items. Four utilities state ants are problematic with transformers.

The most common mitigating measure used to combat underground outages are burying cable in conduit (15 utilities, 26%), using duct sealant (14 utilities, 25%), and using pad mounted ground

sleeves (14 utilities, 25%). Utilities report conduit and duct sealant as very good in preventing animal-caused outages. Conduit also rates very good in long-term durability; duct sealant rates good. Pad mount ground sleeves rate good in deterring animals and very good in long-term durability. No product received an overall excellent rating. Although sample sizes are low (five utilities), there is dissatisfaction with the long-term durability of poisons because they must continually be reapplied. This is problematic when facilities are located in remote areas. Metal mesh embedded cable to deter rodent chewing received a poor rating from two utilities.

4.1.3 Distribution Substation Problems

Fewer animal-caused outage duration and frequency problems are associated with distribution substations. Utilities in this study report that approximately 11% of their animal-caused outage time and 7.3% of their outage events occur on substations. Utilities report climbing mammals cause most problems in both outage duration (48%) and frequency (39%). Tree squirrels and raccoons cause most mammal problems. Squirrel problems appear to be elevated in the spring due to nesting and during fall as squirrels prepare for winter. Birds also cause problems in both outage duration (29%) and frequency (39%). Bird problems appear to be elevated in the spring due to nesting and during fall migration as large numbers of birds' concentrate. Unfortunately, utilities are generally not able to differential bird species and list most problem species as unknown. Snakes also cause significant problems in both outage duration (23%) and frequency (20%).

Fifty percent of responding utilities indicate that certain substations are more prone to animal problems. Certain substations are more problematic either due to local habitat (53%) or substation configuration (28%). Most substation problems (84%) occur on the low side versus the high side (16%). One utility states only 186 of their 688 substations (27%) have experienced an animal caused outage within the past 10 years. Of these, 15 substations (2%) are responsible for 26% of all their substation outages and are more prone due to their location and associated habitat. These substation outages cost the utility an average of $15,000 each in 1997, excluding overhead and indirect costs.

Areas with heavy tree density are also identified as having more squirrel problems. One utility states animal problems increase after new development destroys habitat and animals emigrated from the disturbed area. They noted 83 of their substations experienced 50% more outages when nearby wooded areas came under development. Increasing outages due to seasonal animal migrations were also noted. Some utilities indicate older substations are more prone to outages.

The most problematic substation facilities are breakers/reclosers, power transformers, and bus conductor. These facilities received similar rankings, with 19 to 23 utilities placing them in their list of top five problem items. More utilities (23 out of 48) list breakers/reclosers in their top five list of problems than any other item. Utilities estimate breaker/recloser animal outages result in their greatest percentage of outage time (44%) and are most often caused by tree squirrels and raccoons. Bus conductor outages result in the second greatest percentage of estimated outage time (27%) and are most often caused by tree squirrel, raccoons, and to a lesser extend, unknown bird species. Power transformer (low side) animal outages result in the third greatest percentage of outage time (18%) and are most often caused by raccoons and tree squirrels.

Other problems include power transformer (high side) and regulator by-pass switch outages. Power transformer (high side) animal outages result in the fourth greatest percentage of estimated outage time (11%) and are most often caused by tree squirrel, raccoons, and unknown bird species. Regulator by-pass switch outages result in the fifth greatest percentage of outage time (10%) and are most often caused by snakes.

Many older substations have numerous cavities providing nesting places for birds. The availability of young birds and eggs in substations attracts other problem animals such as owls and raccoons. Accordingly, the most common substation mitigating measures reported by 56 respondents are regular substation bird nest removal (71%) and regular substation perimeter vegetation trimming (59%). Utilities rate mitigation success as very good and long-term durability as good. The use of insulating methods is also common with utilities using insulated bushing covers (57%), insulated jumper/stinger covers (43%), heat-shrink insulation material (27%), and insulating tape (23%). All these methods rate very good in effectiveness and durability. Insulated primary wire (13%) rates as excellent in both effectiveness and durability. Insulating paints (11%) and sprays (4%) were used less frequently and had lower rankings.

A variety of barriers and spikes are used with success and durability ranging from good to very good. Insulated disk barriers are rated excellent for success by one utility. Substation fence modifications (e.g. small-mesh screening, burying fence fabric, snake fences, and electric fences) also rate good to very good in success and durability.

The most common measures to mitigate substation underground problems measures reported by 56 respondents are burying cable in conduit (25%), using duct sealant (25%), and pad mounted ground sleeves (14%). Utilities report conduit, pad mount ground sleeves, and metal mesh as very good in preventing animal-caused outages and durability. Duct sealant rates good in deterring animals and long-term durability.

Sonic distress calls (7%), fake predators (30%), iridescent foil visual deterrents (2%) all rate as good in success but poor in long-term durability. Ultrasonic pest repellers (18%) rate poor in both mitigation success and durability. Strobe light animal deterrents were used by two utilities and failed to deter animals. Although some of these products initially have limited success, animals soon become acclimated to these devices and return.

4.2 Manufacturers' Surveys

Original Equipment Manufacturer's (OEM's) and companies manufacturing animal mitigating products were contacted to collect information on utility-vendor communication regarding animal products. OEM response was low with only 16 responses (9%). Five OEM's indicate specific animal options are available for their products. These products are designed to control a variety of animals and increase product costs up to 10%. Six OEM's state they give serious consideration to minimizing the potential for animal-caused outages when developing new products. Trade shows, sales calls, and catalogs are used most frequently to promote general products and advertising is primarily targeted towards standards engineers, engineering and operations management, purchasing agents, and staff engineers.

Thirteen companies manufacturing animal mitigating products (21%) also responded to the survey and provided information on 45 different animal mitigating products. The most commonly listed controlled mammal species are tree squirrels, ground squirrels, raccoons, opossums and rats. Tree squirrels were listed most frequently with 20 products available. Bird-control measures primarily target birds-of-prey, blackbirds, gulls and pigeons.

The development of outage mitigating products is a new emerging market according to survey responses. Most products (73%) have been on the market for less than 10 years and 21 products (46%) have become available only within the last five years. Catalogs, trade journals, trade shows and word of mouth used most frequently to promote these products. Advertising is primarily targeted towards standards engineers, linemen, engineering management and staff engineers. Although environmental staff may also often be involved in solving animal problems, they are targeted less frequently. The companies also state 28 products (62%) have increasing market demand.

Although many animal protection products are manufactured to comply with ANSI, IEEE and/or ASTM standard products, there are few developed standards specific to animal protection devices themselves. Only eight of 45 products (18%) were designed subject to an ANSI standard and only two of the products (4%) are Rural Utilities Service (RUS)-approved. Although few standards exist, 34 products (76%) have been field and/or laboratory tested. Published field data are available for 27 products (60%). Warranties ranging from one to five years are also offered for 32 products (71%).

Manufacturers cite the following barriers faced when developing and marketing new animal-caused outage mitigating products:

- Cost (due to expensive design and testing).
- Poor utility communication describing their animal problems.
- Difficulty in developing a universal product (due to vast number of utility configurations).
- Utility hesitancy to try new products (especially without name recognition).

Despite these barriers, manufacturers state a willingness to work with utilities to develop new products. Nine companies report a total of 13 utility requests for product modifications and/or enhancements. Twelve requests were fulfilled and customers were either very satisfied or extremely satisfied. One request was not fulfilled because the customer lost interest in the product.

The manufacturers perceive product effectiveness as the most important factor to utilities, just above product cost and maintenance costs. Product life expectancy, material properties and installation labor costs were perceived as a lower utility importance although six power companies (7%) in the utility survey indicate material properties are very important and have a desire to see products with improved ultraviolet resistance.

APPENDIX A – Surveys

1. **Survey on Animal-Caused Outages on Distribution Lines and Substations - Utility Survey**

2. **Manufacturing Survey Related to Animal-Caused Outages on Distribution Lines and Substations – Survey A**

3. **Survey of Manufacturers Producing Animal-Caused Outage Mitigating Products – Survey B**

Survey on Animal-Caused Outages on Distribution Lines and Substations - Utility Survey

Survey on Animal-Caused Outages on Distribution Lines and Substations

Utility Name: _____

Address: _____

City: _____State: _____ Zip Code: _____

Phone number: (____) _____

Section A: General System Outages

Person completing survey Section A : _____

Job title: _____

Phone Number/E-mail address: _____

A1. Does your utility have an action program in place to reduce animal-caused outages?

☐Yes ☐No ☐Unsure

If **YES**, Please answer the following 4 questions. If **NO**, skip to Question A2.

A1a. Briefly describe the animal-caused outage reduction program:

_____

_____

_____

A1b. Has the animal-caused outage reduction program been effective in reducing outages?

☐Yes ☐No ☐Unsure

A1c. Was a cost analysis performed before implementing various portions of the animal-caused outage reduction program?

☐Yes ☐No ☐Unsure

A1d. Listed below are factors that may trigger a utility to install animal deterrents on their electric system. Please review each factor and rate the importance your utility gave each component before implementing animal mitigating measures. Please use the following 4 rankings:

1. Very important
2. Moderately important
3. Somewhat important
4. Not important

Factors	Ranking	Factors	Ranking
Lost Utility Revenue	1 2 3 4	Consumer Complaints	1 2 3 4
Damaged Equipment Cost	1 2 3 4	Economic Impact on Consumers	1 2 3 4
Liability Issues	1 2 3 4	Number of Affected Consumers	1 2 3 4
Power Quality	1 2 3 4	Inconvenience to Consumers	1 2 3 4
Outage Frequency	1 2 3 4	Impacts to Wildlife Species	1 2 3 4
Outage Duration	1 2 3 4	Federal/State Environmental Laws	1 2 3 4
Other _____	1 2 3 4	Other _____	1 2 3 4

_____

A2. Listed below are measures utilities employ to mitigate animal-caused outages in substations, overhead distribution lines, and underground facilities. Please review the list and check each measure your utility has tried. If you have tried additional measures, please add to the list. For each checked item, grade how effective each measure has been in mitigating animal-caused outages. Please also grade your satisfaction with each product's long-term durability. Please use the following grades:

A. Excellent
B. Very Good
C. Good
D. Poor
F. Failed
U. Unknown

Mitigating Measures Specifically Employed to Reduce Animal-Caused Outages	**Substations**	**Overhead Circuits**	**Underground Circuits**	**Mitigation Success** A B C D F U = Unknown	**Long-Term Durability** A B C D F U = Unknown
Insulating Measures					
Wood/Fiberglass Insulated Equipment Mounts					
Insulated Bushing Covers					
Insulated Jumper/Stinger Wires					
Insulated Primary Wire					
Heat-Shrink Insulation Material					
Insulating Tape					
Insulating Paint					
Insulating Spray					
Insulated Pole Wrapping Mastic					
Stirrup Covers					
Silicon Insulator Coating to Reduce Bird Contamination Flashovers					
Extended Length Deadend Insulators to Provide Additional Clearance					
Increased 60" Conductor Separation for Birds-of-prey					
Insulated Bird-of-prey Guards					
Perching/Nesting Management					
Triangle Perch Guards					
Artificial Nesting Platforms					
Artificial Elevated Bird Perches					
Grounding Solutions					
Eliminating Pole-top Ground Wires					
Gapping Pole-top Ground Wires					
Ground Wire Molding or Insulated Ground Wires					
Barriers/Spikes					
Electrostatic Guards					
Insulated Disk Barriers					
Rotating Tube Barriers for Conductors					
Other Type Climbing Guards (Specify) _____					
Metal Needle Wire Guards/Spikes					
Plastic Bird Spikes					

Mitigating Measures Specifically Employed to Reduce Animal-Caused Outages	**Substations**	**Overhead Circuits**	**Underground Circuits**	**Mitigation Success A B C D F U = Unknown**	**Long-Term Durability A B C D F U = Unknown**
Substation Mitigating Measures					
Regular Substation Perimeter Vegetation Trimming					
Regular Substation Bird Nest Removal					
Burying Fence Fabric into Substation Trap Rock					
Substation Snake Fences					
Small-mesh Substation Screening					
Electric Fences					
Other Fence Modifications (Specify) _____					
Underground Mitigating Measures					
Pad Mount Ground Sleeves					
Buried Cable in Conduit to Deter Rodent Chewing					
Metal Mesh Embedded Cable to Deter Rodent Chewing					
Duct Sealant					
Other Mitigating Measures					
Sonic Distress or Alarm Calls					
Ultrasonic Pest Repeller					
Strobe Light Animal Deterrent					
Grease and Gel Coatings					
Nets to Deter Bird Nesting/Roosting					
Fake Predators (Plastic Owl, Hawk, etc.)					
Iridescent Foil Visual Deterrents					
Odor Type Repellent (Specify type) _____					
Taste Type Repellent (Specify type) _____					
Poison (Specify Type) _____					
Trapping					
Other (Specify) _____					
Other (Specify) _____					
Other (Specify) _____					
Other (Specify) _____					
Other (Specify) _____					

_____

A3. Did any animal mitigating measures cause any new outage or maintenance problems?

☐Yes ☐No ☐Unsure

A3a. If **YES**, please elaborate:

_____

_____

_____

A4. Are there any modifications to existing products or new products that you would like to see?

☐Yes ☐No ☐Unsure

A4a. If **YES**, please elaborate:

_____

_____

_____

A5. Annual animal-caused outage time per consumer is:

☐ Decreasing ☐ Increasing ☐ Staying constant ☐ Unsure

A5a. If annual animal-caused outage time per consumer is either decreasing or increasing, please explain why:

_____

_____

_____

A6. Does your utility use a structured method for calculating outage costs?

☐Yes ☐No ☐Unsure

A6a. If **YES**, please check all factors used to determine costs.

Outage Cost Factors	Factors	Outage Cost Factors	Factors
Lost Utility Revenue		Labor to Repair Damaged Equipment	
Time of Day, Week, or Year		Labor to Locate and Clear Faults	
Outside Temperature		Type of Customer	
Location (e.g. urban, rural)		Impact to Consumer Relations	
Economic Impact on Consumers		Civil Litigation/Fines	
Damaged Equipment Cost		Other (Specify) _____	

A6b. If you utilize a specific formula to calculate outage costs, please list and describe:

_____

_____

_____

_____

A6c. If available, provide or list system historic outage **cost** data (total from all causes) from 1993 to 1997 below:

1993 _____ Dollars 1996 _____ Dollars

1994 _____ Dollars 1997 _____ Dollars

1995 _____ Dollars

A7. Are animal-caused outages elevated at certain times of the year?

☐Yes ☐No ☐Unsure

A7a. If **YES**, when and why are they elevated?

_____

_____

_____

_____

_____

A8. Please enter or provide the miles of overhead distribution line, underground distribution cable, and transmission line (69kV and above) your utility has owned, operated, and maintained for the past 5 years. Also enter the number of distribution substations owned, operated, and maintained.

Utility Facilities	1993	1994	1995	1996	1997
Distribution Overhead Line					
Distribution Underground Cable					
Transmission (69kV and above)					
Distribution Substations					

A9. Please enter or provide the number of customers served for the past 5 years by rate classification.

Rate Classification	1993	1994	1995	1996	1997
Industrial					
Small Commercial					
Residential					
Other					
Total Customers					

A10. In order to determine the economic impact of animal-caused outages it is important to quantify outage statistics. If available, provide or list system historic outage **duration** data (total from all causes) from 1993 to 1997 below:

1993 _____ Hours/Consumer/Year
1994 _____ Hours/Consumer/Year
1995 _____ Hours/Consumer/Year
1996 _____ Hours/Consumer/Year
1997 _____ Hours/Consumer/Year

Note: If another method is used to quantify outage performance, please enter above and check the method used: ☐SAIFI ☐CAIFI ☐CAIDI ☐ASAI ☐ATPII ☐Other (Specify) _____

A10a. Listed below are typical outage causes. Please enter or estimate outage **duration** percentages for each system outage cause from 1993 to1997. If data are available by animal type (i.e. birds, mammals, reptiles) please list accordingly as this level of detail will greatly help target specific animal-caused problems. If data are not available for all years, please provide any data that are available.

Typical Outage Causes	**1993 Outage Duration Percent**	**1994 Outage Duration Percent**	**1995 Outage Duration Percent**	**1996 Outage Duration Percent**	**1997 Outage Duration Percent**
Unknown					
Animal					
Species - Birds					
Species - Mammals					
Species - Reptiles					
Species - _____					
Vehicle Accident					
Trees					
Wind					
Lightning					
Ice/Snow					
Other (List) _____					
Other (List) _____					
Total	**100%**	**100%**	**100%**	**100%**	**100%**

The above percentages are: ☐Estimated ☐Actual

A10b. Please refer to the above table and approximate the percent of historic **animal-caused** outages occurring on:

Overhead Distribution Lines _____% Animal-Caused
Underground Distribution Circuits _____% Animal-Caused
Substations _____% Animal-Caused
Transmission Lines _____% Animal-Caused
Total 100%

A11. Many utilities do not classify an interruption as an "outage" until its duration exceeds approximately 5 minutes. Do your outage records include momentary outages cleared by recloser and breaker operations?

☐Yes ☐No ☐Unsure

_____

A12. Do the interruption data include transmission outages?

☐Yes ☐No ☐Unsure

A13. If available, provide or list system historic outage **event** data (total from all causes) from 1993 to 1997 below:

1993 _____ Events/Consumer/Year 1996 _____ Events/Consumer/Year

1994 _____ Events /Consumer/Year 1997 _____ Events/Consumer/Year

1995 _____ Events /Consumer/Year

A13a. Listed below are typical outage causes. Please enter or estimate outage **event** percentages for each system outage cause from 1993 to1997. If data are available by animal type (i.e. birds, mammals, reptiles) please list accordingly as this level of detail will greatly help target specific animal-caused problems. If data are not available for all years, please provide any data that are available.

Typical Outage Causes	**1993 Outage Event Percent**	**1994 Outage Event Percent**	**1995 Outage Event Percent**	**1996 Outage Event Percent**	**1997 Outage Event Percent**
Unknown					
Animal					
Species - Birds					
Species - Mammals					
Species - Reptiles					
Species - _____					
Vehicle Accident					
Trees					
Wind					
Lightning					
Ice/Snow					
Other (List) _____					
Other (List) _____					
Total	**100%**	**100%**	**100%**	**100%**	**100%**

The above percentages are: ☐Estimated ☐Actual

A13b. Please refer to the above table and approximate the percent of historic **animal-caused** outage events occurring on:

Overhead Distribution Lines _____% Animal-Caused

Underground Distribution Circuits _____% Animal-Caused

Substations _____% Animal-Caused

Transmission Lines _____% Animal-Caused

Total 100%

A14. If you have detailed animal-caused outage data, would you be willing to participate in a more in-depth outage study?

☐Yes ☐No

_____

Section B: Distribution Overhead Animal-Caused Outages

Person completing survey Section B : _____

Job title: _____

Phone Number/E-mail address: _____

B1. Please check all distribution voltage classes included in your system.

0-5kV____ 6-15kV _____ 16-25kV _____ 26-34.5kV ____ Other (Specify) _____

B2. Listed below are some historic animal problems associated with distribution overhead powerlines. Please complete the table using the following instructions:

Column A – Please check all problems encountered on your system within the past 5 years. Also indicate problem animal species. A list of various animals known to cause outages is provided on Page 14.

Column B – Rank each checked problem in order of its **economic significance**, with 1 being your most significant distribution overhead problem.

(A) Historic Distribution Overhead Problems	(B) Rank Problems
☐ Tree squirrels contacting energized wires/apparatus	
☐ Other mammals contacting energized wires/apparatus: Animal _____	
☐ Large mammals rubbing poles and/or guy wires: Animal _____	
☐ Birds-of-prey contacting energized wires/apparatus	
☐ Other birds contacting energized wires/apparatus (List species if known) _____	
☐ Flocks of small birds causing excessive sag and/or conductor jumping/swinging	
☐ Birds-of-prey nests on distribution lines (List species if known) _____	
☐ Other bird nests on distribution lines (List species if known) _____	
☐ Woodpeckers causing structural failure	
☐ Fecal contamination flashovers caused by birds (List species if known) _____	
☐ Insects on gapped arresters (List species if known) _____	
☐ Snakes climbing poles and contacting energized wires/apparatus	
☐ Other Problems (Please list)	
☐ Other Problems (Please list)	

B3. Please list the animal that causes the greatest duration of overhead outages: _____

B4. Please list the animal that causes the greatest frequency of overhead outages: _____

B5. Listed below are items associated with distribution overhead lines and animal-caused outages. Please complete the table using the following instructions:

Column A – Check each item associated with an animal-caused outage on your distribution overhead system within the past 5 years.
Column B – Rank your 5 most problematic overhead items in order of **consumer interruption time**, with 1 being your most significant problem.
Column C – For each of the 5 problem items identified in Column B, estimate the percent **consumer interruption time** associated with animal-caused interruptions.
Column D – Rank your 5 most problematic overhead items in order of **number of consumer interruptions**, with 1 being your most significant animal-caused problem.
Column E – Indicate by number all problem animal species encountered. Refer to page 14 for a list of animal codes.

(A) Distribution Overhead Items Associated with Animal-Caused Outages	(B) Rank Consumer Interruption Time (1 – 5)	(C) Estimate % Consumer Interruption Time	(D) Rank Number of Consumer Interruptions (1 – 5)	(E) List of All Animal Species Encountered
☐ Power transformers				
☐ Regulators				
☐ Capacitors				
☐ Breakers				
☐ Reclosers				
☐ Sectionalizers				
☐ Surge arresters				
☐ Cutouts				
☐ Switchgear				
☐ Potheads at riser locations				
☐ Pole-top ground wires				
☐ Grounded pole-top hardware				
☐ Phase-to-phase conductor contacts				
☐ Phase-to-neutral contacts				
☐ Jumper wires contacts				
☐ Insulator contamination				
☐ Conductor jumping				
☐ Structural Failure				
☐ Unknown				
☐ Other Problems (Please list)				
☐ Other Problems (Please list)				
☐ Other Problems (Please list)				

B6. Do certain overhead circuits on your system have significantly more animal-caused outages than others?

☐Yes ☐No ☐Unsure

B6a. If **YES**, why do you think these circuits are uniquely prone to more outages:

☐ Unsure ☐ Line configuration
☐ Location/Habitat ☐ Other (Specify) _____

_____

Section C: Distribution Underground Animal-Caused Outages

Person completing survey Section C : _____

Job title: _____

Phone Number/E-mail address: _____

C1. Listed below are some historic animal problems associated with distribution underground circuits. Please complete the table using the following instructions:

Column A – Please check all problems encountered on your system within the past 5 years. Also indicate problem animal species. A list of various animals known to cause outages is provided on Page 14.

Column B – Rank each problem in order of its **economic significance**, with 1 being your most significant underground problem.

(A) Historic Distribution Underground Problems	**(B)** **Rank Problems**
☐ Chewing UG primary cable: Animal _____	
☐ Chewing UG secondary cable: Animal _____	
☐ Chewing UG service cable: Animal _____	
☐ Burrowing into UG cabinets and filling them with dirt: Animal _____	
☐ Burrowing into UG cabinets and chewing cable/apparatus: Animal _____	
☐ Burrowing into UG cabinets and contacting bare bus work/apparatus:	
☐ Burrowing into UG cabinets and degrading the foundations:	
☐ Erosion due to animal tunnels: Animal _____	
☐ Snakes nesting/living in pad mounted equipment	
☐ Fire ants nesting/living in pad mounted equipment	
☐ Spiders in UG cabinets	
☐ Wasps in UG cabinets	
☐ Fecal contamination in cabinets (List species if known) _____	
☐ Other Problems (Please List)	
☐ Other Problems (Please List)	

C2. Please list the animal that causes the greatest duration of underground outages: _____

C3. Please list the animal that causes the greatest frequency of underground outages: _____

C4. Listed below are items associated with distribution underground circuits and animal-caused outages. Please complete the table using the following instructions:

Column A – Check each item associated with an animal-caused outage on your underground system within the past 5 years.
Column B – Rank your 5 most problematic underground items in order of **consumer interruption time**, with 1 being your most significant problem.
Column C – For each of the 5 problem items identified in Column B, estimate the percent **consumer interruption time** associated with animal-caused interruptions.
Column D – Rank your 5 most problematic underground items in order of **number of consumer interruptions**, with 1 being your most significant animal-caused problem.
Column E – Indicate by number all problem animal species encountered. Refer to page 14 for a list of animal codes.

(A) Distribution Underground Items Associated with Animal-Caused Outages	(B) Rank Consumer Interruption Time (1 –5)	(C) Estimate % Consumer Interruption Time	(D) Rank Number of Consumer Interruptions (1 –5)	(E) List of All Animal Species Encountered
☐ UG primary cable				
☐ UG secondary cable				
☐ UG service cable				
☐ Subsurface/Pad mounted transformer				
☐ Subsurface/Pad mounted sectionalizer				
☐ Subsurface/Pad mounted switch				
☐ UG elbow termination				
☐ Jumper in pad mounted equipment				
☐ Bus work in pad mounted equipment				
☐ UG ground rod				
☐ Equipment enclosures				
☐ Sleeves				
☐ Equipment pads				
☐ Unknown				
☐ Other Problems (Please List) _____				
☐ Other Problems (Please List) _____				
☐ Other Problems (Please List) _____				

C5. Do certain underground circuits on your system have significantly more frequent animal-caused outages than others?

☐Yes ☐No ☐Unsure

C5a. If **YES**, why do you think these circuits are uniquely prone to more outages:

☐ Unsure
☐ Location/Habitat
☐ Other (Specify) _____

_____

Section D: Distribution Substation Animal-Caused Outages

Person completing survey Section D : _____

Job title: _____

Phone Number/E-mail address: _____

D1. What are your distribution substation voltages? (e.g. 161 – 23/13.2kV)

_____ , _____ , _____ , _____ , _____

D2. Listed below are items associated with distribution substations and animal-caused outages. Please complete the table using the following instructions:

Column A – Check each item associated with an animal-caused outage on your distribution substation system within the past 5 years.
Column B – Rank your 5 most problematic substation items in order of **consumer interruption time**, with 1 being your most significant problem.
Column C – For each of the 5 problem items identified in Column B, estimate the percent **consumer interruption time** associated with animal-caused interruptions.
Column D – Rank your 5 most problematic substation items in order of **number of consumer interruptions**, with 1 being your most significant animal-caused problem.
Column E – Indicate by number all problem animal species encountered. Refer to page 14 for a list of animal codes.

(A) Substation Items Associated with Animal-Caused Outages	(B) Rank Consumer Interruption Time (1 –5)	(C) Estimate % Consumer Interruption Time	(D) Rank Number of Consumer Interruptions (1 –5)	(E) List of All Animal Species Encountered
☐ Bus conductor				
☐ Power transformer – high side				
☐ Power transformer – low side				
☐ Regulator and by-pass switch				
☐ Capacitor				
☐ Breaker/Recloser				
☐ Control wiring				
☐ Surge arrester				
☐ Voltage and current transformers				
☐ Switchgear				
☐ Insulator contamination				
☐ Pothead				
☐ Jumper Wires				
☐ Unknown				
☐ Other Problems (Please List) _____				
☐ Other Problems (Please List) _____				
☐ Other Problems (Please List) _____				

D3. Please list the animal that causes the greatest duration of substation outages: _____

D4. Please list the animal that causes the greatest frequency of substation outages: _____

D5. Percent of substation outages occurring on the Low Side: _____%
High Side: _____%
Unknown ☐

D6. Do you record detailed substation outage information?
☐Yes ☐No ☐Unsure

D7. Do certain substations have significantly more frequent animal-caused outages than others do?
☐Yes ☐No ☐Unsure

D7a. If **YES**, why do you think these substations are uniquely prone to more outages?
☐ Unsure ☐ Substation configuration
☐ Location/Habitat ☐ Other (Specify) _____

D7b. Please provide additional details to clarify why certain substations may be more prone to animal-caused outages:

_____
_____
_____
_____

D8. Do you have a regular substation bird nest removal program?
☐Yes ☐No ☐Unsure

D9. Would you be willing to participate in a study to test the effectiveness of various substation corrective actions designed to prevent animal-caused outages?
☐Yes ☐No

Please include a copy of your outage reporting form and any photos illustrating animal-caused equipment damage. Credit will be given for any published photos and all original photos will be returned.

Animal Codes

Mammals (1-40):

1. Antelope
2. Armadillo
3. Badger
4. Bat
5. Bear
6. Beaver
7. Bison
8. Bobcat
9. Cat–Domestic
10. Cow
11. Coyote
12. Deer
13. Dog
14. Fox
15. Gopher
16. Groundhog
17. Horse
18. Mink
19. Mole
20. Moose
21. Mountain Lion
22. Mouse
23. Opossum
24. Pig
25. Porcupine
26. Rabbit
27. Raccoon
28. Rat
29. Ringtail
30. Shrew
31. Skunk
32. Squirrel - Ground
33. Squirrel - Tree
34. Weasel
35. Wolf
36. Unknown Mammal
37. Other _____
38. Other _____
39. Other _____
40. Other _____

Birds (41-55):

41. Eagle
42. Hawk
43. Owl
44. Osprey
45. Falcon
46. Vulture
47. Unknown Raptor
48. Blackbird
49. Gull
50. Unknown Bird
51. Other _____
52. Other _____
53. Other _____
54. Other _____
55. Other _____

Miscellaneous (56-65):

56. Insects – Ants
57. Unknown Insect
58. Insects – Specify if known _____
59. Snake
60. Lizard
61. Frog
62. Salamander
63. Other _____
64. Other _____
65. Other _____

Mail or Fax Completed Survey Form to:

Ron Randle
EDM
4001 Automation Way
Fort Collins, Colorado 80525-3479

Fax: 970/204-4007
Voice: 970/204-4001
E-mail: rrandle@edmlink.com

Manufacturing Survey Related to Animal-Caused Outages on Distribution Lines and Substations – Survey A

Manufacturing Survey Related to Animal-Caused Outages on Distribution Lines and Substations – Survey A

Company Name: _____

Address: _____

City: _____State: _____ Zip Code: _____

Person completing survey: _____

Job title: _____

Phone number: (____) _____

E-mail address: _____

Section A: Product Information

A1. In the following table please mark all products your company either manufactures, sells, or distributes to the electric utility industry. Please provide additional product information using the following instructions:

Column A – Check each of your electric utility products.
Column B – Check any products offering animal-proof options.
Column C – If an animal-proof option is available, indicate by number all primary animal species each product is designed to protect. Refer to page 6 for a list of animal codes.
Column D - If an animal-proof option is available, enter the percent cost increase of the option.
Column E – If animal-proof options are not available, indicate how difficult it would be to modify each product to reduce the chances of animal-caused outages.

Note: If animal protection options are commercially available, please include descriptive product catalog sheets.

(A) **Product Description**	(B) Animal Proof Option ?	(C) List of All Primary Animal Species Controlled *	(D) Cost Increase in Percent	(E) Difficulty to Animal Proof 1 = Extremely Difficult 2 = Very Difficult 3 = Difficult 4 = Somewhat Difficult 5 = Not Difficult 6= Not Applicable
Overhead Distribution Products				
❒ Arrester				
❒ Cutout, fused				
❒ Arrester/Cutout Combination				
❒ Recloser				
❒ Sectionalizer				
❒ Breaker				
❒ Regulator				
❒ Transformer				
❒ Capacitor				
❒ Pole (Specify Type)				

* See species list on page 6 for animal codes.

(A) **Product Description**	(B) Animal Proof Option ?	(C) List of All Primary Animal Species Controlled *	(D) Cost Increase in Percent	(E) Difficulty to Animal Proof 1 = Extremely Difficult 2 = Very Difficult 3 = Difficult 4 = Somewhat Difficult 5 = Not Difficult 6= Not Applicable
❒ Pole Hardware				
❒ Crossarm				
❒ Crossarm Assembly				
❒ Conductor/Jumper				
❒ Insulator				
❒ Switch, Pole top				
❒ Switch, Bypass				
❒ Switch, Other (Specify)				
❒ Other (Specify)				
❒ Other (Specify)				
❒ Other (Specify)				
Underground Distribution Products				
❒ Arrester				
❒ Arrester/Cutout Combination				
❒ Bracket, Riser				
❒ Cable, Primary				
❒ Cable, Secondary				
❒ Enclosure				
❒ Regulator				
❒ Switch				
❒ Termination				
❒ Transformer, Padmount				
❒ Transformer, Vault type				
❒ Other (Specify)				
❒ Other (Specify)				
Distribution Substation Products				
❒ Arrester				
❒ Cutout				
❒ Switch - Disconnect				
❒ Switch – Regulator bypass				
❒ Switch - Other (Specify)				
❒ Circuit switcher				
❒ Power transformer				
❒ Meter and associated hardware				
❒ Regulator				
❒ Recloser				
❒ Breaker				
❒ Capacitor				
❒ Fuse				
❒ Bus work				
❒ Structural support				
❒ Hardware				
❒ Insulator				
❒ Control/power cable				
❒ Perimeter fence				
❒ Other (Specify)				
❒ Other (Specify)				
❒ Other (Specify)				

* See species list on page 6 for animal codes.

A2. Please check the following box that best describes the amount of consideration your company gives to minimizing the potential for animal-caused outages when developing new products.

❒ 1 - Serious Consideration
❒ 2 - Moderate Consideration
❒ 3 - Some Consideration
❒ 4 - No Consideration
❒ 5 - Not Applicable

A3. Listed below are common outage causes that impact electric power system reliability. Please indicate how seriously you perceive each outage cause impacts distribution overhead, distribution underground, and distribution substation reliability. Rate each category using the following scale:

1 = Extremely Serious Impact
2 = Very Serious Impact
3 = Serious Impact
4 = Somewhat Serious Impact
5 = No Serious Impact

Outage Causes	Distribution Overhead	Distribution Underground	Distribution Substations
Lightning	**1 2 3 4 5**	**1 2 3 4 5**	**1 2 3 4 5**
Wind	**1 2 3 4 5**	**1 2 3 4 5**	**1 2 3 4 5**
Ice/Snow	**1 2 3 4 5**	**1 2 3 4 5**	**1 2 3 4 5**
Trees/Debris	**1 2 3 4 5**	**1 2 3 4 5**	**1 2 3 4 5**
Vehicle Accidents	**1 2 3 4 5**	**1 2 3 4 5**	**1 2 3 4 5**
Animals	**1 2 3 4 5**	**1 2 3 4 5**	**1 2 3 4 5**
Unknown	**1 2 3 4 5**	**1 2 3 4 5**	**1 2 3 4 5**

Section B: Product Marketing

An EPRI utility wildlife pest control workshop was recently held in Scottsdale, Arizona. During the workshop, utility personnel indicated that they are sometimes unaware of products that can successfully combat animal-caused outage problems. The following questions are designed to determine how manufacturers disseminate product information to the utility industry.

B1. Listed below are factors that may trigger a utility to install animal deterrents on their electric system. Please review each factor and rate the importance you perceive a utility gives it when deciding whether to implement animal mitigating measures. Please use the following 4 rankings:

1. Very important
2. Moderately important
3. Somewhat important
4. Not important

Factors	Ranking	Factors	Ranking
Lost Utility Revenue	1 2 3 4	Consumer Complaints	1 2 3 4
Damaged Equipment Cost	1 2 3 4	Economic Impact on Consumers	1 2 3 4
Liability Issues	1 2 3 4	Number of Affected Consumers	1 2 3 4
Power Quality	1 2 3 4	Inconvenience to Consumers	1 2 3 4
Outage Frequency	1 2 3 4	Impacts to Wildlife Species	1 2 3 4
Outage Duration	1 2 3 4	Federal/State Environmental Laws	1 2 3 4

B2. The following table lists various advertising methods used by manufacturers for disseminating product information. Please complete the table using the following instructions:

Column A – Check each method used to promote general utility products.
Column B – Check each method used to promote products specifically designed to mitigate animal-caused outages.
Column C – Circle the code letter(s) for the utility group(s) targeted with each advertising method. Complete this column using the advertising target group codes listed below the table.

Advertising Methods	(A) General Product Advertising	(B) Animal Outage Mitigating Product Advertising	(C) Advertising Target Group(s)*
1. Trade Journals			A B C D E F G H I J K L M
2. Trade Shows			A B C D E F G H I J K L M
3. Word of Mouth			A B C D E F G H I J K L M
4. Web Site			A B C D E F G H I J K L M
5. Sales Calls			A B C D E F G H I J K L M
6. Case Studies			A B C D E F G H I J K L M
7. Video Tapes			A B C D E F G H I J K L M
8. Catalogs			A B C D E F G H I J K L M
9. Professional Papers			A B C D E F G H I J K L M
10. Professional Presentations			A B C D E F G H I J K L M
11. Product Mailings			A B C D E F G H I J K L M
12. Other (List) _____			A B C D E F G H I J K L M

* Advertising Target Group Codes:

A. General Management
B. Engineering Management
C. Staff Engineers
D. Purchasing Agents
E. Standards Engineers
F. Staking Engineers
G. Technicians
H. Environmental Staff
I. Operations Management
J. Linemen
K. Other (List)_____
L. Consultants
M. All of the Above

Section C: Product Development

C1. In the following table please describe any requests for product modifications/enhancements your company has been asked to make to mitigate animal-caused outages. Instructions for completing the table are listed below:

Column A – Briefly describe the animal-caused problem and proposed utility solution.
Column B – Indicate how many individual utilities requested this same type of product modification.
Column C – Indicate if your company made, or will make, product modifications to address the animal-caused problem.
Column D – If no modifications have been, or will be made, please indicate why. See footnote #1 below table.
Column E – If any product changes were made, please indicate your perception of the utility industry's satisfaction with the modifications. See footnote #2 below table.

(A) Problem Description and Requested Product Modifications	(B) Number of Utility Requests	(C) Product Modified?	(D) If Not, Why?	(E) Customer Reaction
(1) _____ _____ _____	❒ 1 - 4 ❒ 5 - 9 ❒ 10+	❒ Yes ❒ No ❒ Unsure	1 2 3 4 5 6	A B C D F U
(2) _____ _____ _____	❒ 1 - 4 ❒ 5 - 9 ❒ 10+	❒ Yes ❒ No ❒ Unsure	1 2 3 4 5 6	A B C D F U
(3) _____ _____ _____	❒ 1 - 4 ❒ 5 - 9 ❒ 10+	❒ Yes ❒ No ❒ Unsure	1 2 3 4 5 6	A B C D F U

Footnote #1 – Codes for Column D:

1. Problem Not Deemed Significant
2. No Technical Solution Found
3. Cost Prohibitive
4. Solution Still Being Developed
5. Alternative Measures/Products Already Exist
6. Other (List)_____

Footnote #2 – Codes for Column E:

A. Extremely Satisfied
B. Very Satisfied
C. Satisfied
D. Somewhat Satisfied
F. Dissatisfied
U. Unknown

C2. - Optional

What barriers, if any, do you face when developing and marketing new animal-caused outage mitigating products?

_____
_____
_____
_____
_____
_____

Animal Codes

Mammals (1-40):

1. Antelope	13. Dog	25. Porcupine	37. Other _____
2. Armadillo	14. Fox	26. Rabbit	38. Other _____
3. Badger	15. Gopher	27. Raccoon	39. Other _____
4. Bat	16. Groundhog	28. Rat	40. Other _____
5. Bear	17. Horse	29. Ringtail	
6. Beaver	18. Mink	30. Shrew	
7. Bison	19. Mole	31. Skunk	
8. Bobcat	20. Moose	32. Squirrel - Ground	
9. Cat–Domestic	21. Mountain Lion	33. Squirrel - Tree	
10. Cow	22. Mouse	34. Weasel	
11. Coyote	23. Opossum	35. Wolf	
12. Deer	24. Pig	36. Unknown Mammal	

Birds (41-55):

41. Eagle	46. Vulture	51. Other _____
42. Hawk	47. Unknown Raptor	52. Other _____
43. Owl	48. Blackbird	53. Other _____
44. Osprey	49. Gull	54. Other _____
45. Falcon	50. Unknown Bird	55. Other _____

Miscellaneous (56-65):

56. Insects – Ants	61. Frog
57. Unknown Insect	62. Salamander
58. Insects – Specify if known _____	63. Other _____
59. Snake	64. Other _____
60. Lizard	65. Other _____

Mail or Fax Completed Survey Form to:

Ron Randle
EDM
4001 Automation Way
Fort Collins, Colorado 80525-3479

Fax: 970/204-4007
Voice: 970/204-4001
E-mail: rrandle@edmlink.com

Survey of Manufacturers Producing Animal-Caused Outage Mitigating Products – Survey B

Survey of Manufacturers Producing Animal-Caused Outage Mitigating Products - Survey B

Company Name: _____

Address: _____

City: _____State: _____ Zip Code: _____

Person completing survey: _____

Job title: _____

Phone number: (____) _____

E-mail address: _____

Section A: Product Information

A1. In the following table please list all products your company either manufactures, sells, or distributes specifically to protect animals, mitigate outages, or minimize the probability of damage to electric utility equipment. Please include product catalog sheets describing and depicting each product item. Instructions for completing the table are listed below:

Column A – List animal-caused outage mitigating products.
Column B – Indicate how long each product has been commercially available.
Column C – Indicate by number all primary animal species each product is designed to protect. Refer to page 5 for a list of animal codes.
Column D – Note if the utility demand for each product is increasing, decreasing, constant, or unknown.
Column E – Using codes listed below the table, enter the primary product concern(s) you must address when trying to convince utilities to install each product.

(A) Product Name/Description	(B) No. of Years Available	(C) List of All Primary Animal Species Controlled *	(D) Demand I = Increasing D = Decreasing C = Constant U = Unknown	(E) Primary Utility Product Concern(s) **
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

*See species list on page 5 for animal codes.

** Utility Product Concern Codes:

A. Product Cost	D. Maintenance Costs	G. Material Properties
B. Installation Labor Cost	E. Product Effectiveness	H. Product Life Expectancy
C. Appearance/Aesthetics	F. Long-Term Cost Benefit	I. Other (List)_____

A2. Which of the product concerns listed in the previous table (column E) do you perceive to be the most important to utilities?

_____ 1st _____ 2nd _____ 3rd

A3. The previous Table lists products your company either manufactures, sells, or distributes to reduce animal-caused outages. In the following table please provide additional product information using the following instructions:

Column A – Check which products are covered by ANSI /IEEE standards.
Column B – Check which products are approved for use on Rural Utilities Service (RUS) systems.
Column C – Check the types of product testing utilized, if any.
Column D – Indicate if published field performance data are available. If published field data are available, please include a copy.
Column E – Indicate if the testing was done either in house or by a third party.
Column F – Enter the length of any warranty.

Product No.	(A) ANSI/ IEEE Std?	(B) RUS Approved?	(C) Test Types 1 = Electrical 2 = Mechanical 3 = Exposure	(D) Published Field Data? (Y – N)	(E) **T**est Source 1 = In House 2 = 3rd Party	(F) Warranty Length
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

Section B: Product Marketing

An EPRI utility wildlife pest control workshop was recently held in Scottsdale, Arizona. During the workshop, utility personnel indicated that they are sometimes unaware of products that can successfully combat animal-caused outage problems. The following questions are designed to determine how manufacturers disseminate product information to the utility industry.

B1. Listed below are factors that may trigger a utility to install animal deterrents on their electric system. Please review each factor and rate the importance you perceive a utility gives it when deciding whether to implement animal mitigating measures. Please use the following 4 rankings:

1. Very important
2. Moderately important
3. Somewhat important
4. Not important

Factors	Ranking	Factors	Ranking
Lost Utility Revenue	1 2 3 4	Consumer Complaints	1 2 3 4
Damaged Equipment Cost	1 2 3 4	Economic Impact on Consumers	1 2 3 4
Liability Issues	1 2 3 4	Number of Affected Consumers	1 2 3 4
Power Quality	1 2 3 4	Inconvenience to Consumers	1 2 3 4
Outage Frequency	1 2 3 4	Impacts to Wildlife Species	1 2 3 4
Outage Duration	1 2 3 4	Federal/State Environmental Laws	1 2 3 4

B2. The following table lists various advertising methods used by manufacturers for disseminating product information. In the first column, check each method used by your company to promote products specifically designed to mitigate animal-caused outages. In the last column, please circle the code letter(s) for the utility group(s) targeted with each advertising method. Complete the last column using the codes listed below the table.

	Advertising Methods		Advertising Target Group(s)*
1.	Trade Journals	❒	A B C D E F G H I J K L M
2.	Trade Shows	❒	A B C D E F G H I J K L M
3.	Word of Mouth	❒	A B C D E F G H I J K L M
4.	Web Site	❒	A B C D E F G H I J K L M
5.	Sales Calls	❒	A B C D E F G H I J K L M
6.	Case Studies	❒	A B C D E F G H I J K L M
7.	Video Tapes	❒	A B C D E F G H I J K L M
8.	Catalogs	❒	A B C D E F G H I J K L M
9.	Professional Papers	❒	A B C D E F G H I J K L M
10.	Professional Presentations	❒	A B C D E F G H I J K L M
11.	Product Mailings	❒	A B C D E F G H I J K L M
12.	Other (List) _____	❒	A B C D E F G H I J K L M

* Advertising Target Group Codes:

A. General Management
B. Engineering Management
C. Staff Engineers
D. Purchasing Agents
E. Standards Engineers
F. Staking Engineers
G. Technicians
H. Environmental Staff
I. Operations Management
J. Linemen
K. Other (List)_____
L. Consultants
M. All of the Above

_____

Section C: Product Development

C1. In the following table please describe any requests for product modifications/enhancements your company has been asked to make to mitigate animal-caused outages. Instructions for completing the table are listed below:

Column A – Briefly describe the animal-caused problem and proposed utility solution.
Column B – Indicate how many individual utilities requested this same type of product modification.
Column C – Indicate if your company made, or will make, product modifications to address the animal-caused problem.
Column D – If no modifications have been, or will be made, please indicate why. See footnote #1 below table.
Column E – If any product changes were made, please indicate your perception of the utility industry's satisfaction with the modifications. See footnote #2 below table.

(A) Problem Description and Requested Product Modifications	(B) Number of Utility Requests	(C) Product Modified?	(D) If Not, Why?	(E) Customer Reaction
(1) _____ _____ _____	❒ 1 - 4 ❒ 5 - 9 ❒ 10+	❒ Yes ❒ No ❒ Unsure	1 2 3 4 5 6	A B C D F U
(2) _____ _____ _____	❒ 1 - 4 ❒ 5 - 9 ❒ 10+	❒ Yes ❒ No ❒ Unsure	1 2 3 4 5 6	A B C D F U
(3) _____ _____ _____	❒ 1 - 4 ❒ 5 - 9 ❒ 10+	❒ Yes ❒ No ❒ Unsure	1 2 3 4 5 6	A B C D F U

Footnote #1 – Codes for Column D:

1. Problem Not Deemed Significant
2. No Technical Solution Found
3. Cost Prohibitive
4. Solution Still Being Developed
5. Alternative Measures/Products Already Exist
6. Other (List)_____

Footnote #2 – Codes for Column E:

A. Extremely Satisfied
B. Very Satisfied
C. Satisfied
D. Somewhat Satisfied
F. Dissatisfied
U. Unknown

C2. - Optional

What barriers, if any, do you face when developing and marketing new animal-caused outage mitigating products?

_____
_____
_____
_____
_____
_____

Animal Codes

Mammals (1-40):

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2. Armadillo	14. Fox	26. Rabbit	38. Other _____
3. Badger	15. Gopher	27. Raccoon	39. Other _____
4. Bat	16. Groundhog	28. Rat	40. Other _____
5. Bear	17. Horse	29. Ringtail	
6. Beaver	18. Mink	30. Shrew	
7. Bison	19. Mole	31. Skunk	
8. Bobcat	20. Moose	32. Squirrel - Ground	
9. Cat–Domestic	21. Mountain Lion	33. Squirrel - Tree	
10. Cow	22. Mouse	34. Weasel	
11. Coyote	23. Opossum	35. Wolf	
12. Deer	24. Pig	36. Unknown Mammal	

Birds (41-55):

41. Eagle	46. Vulture	51. Other _____
42. Hawk	47. Unknown Raptor	52. Other _____
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44. Osprey	49. Gull	54. Other _____
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Miscellaneous (56-65):

56. Insects – Ants	61. Frog
57. Unknown Insect	62. Salamander
58. Insects – Specify if known _____	63. Other _____
59. Snake	64. Other _____
60. Lizard	65. Other _____

Mail or Fax Completed Survey Form to:

Ron Randle
EDM
4001 Automation Way
Fort Collins, Colorado 80525-3479

Fax: 970/204-4007
Voice: 970/204-4001
E-mail: rrandle@edmlink.com

About EPRI

EPRI creates science and technology solutions for the global energy and energy services industry. U.S. electric utilities established the Electric Power Research Institute in 1973 as a nonprofit research consortium for the benefit of utility members, their customers, and society. Now known simply as EPRI, the company provides a wide range of innovative products and services to more than 1000 energy-related organizations in 40 countries. EPRI's multidisciplinary team of scientists and engineers draws on a worldwide network of technical and business expertise to help solve today's toughest energy and environmental problems.

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TE-114915

Printed on recycled paper in the United States of America

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