BIRD-BANDING
A Journal of Ornithological Investigation

Vol. XXXV | October, 1964 | No. 4

WOODPECKER DAMAGE TO UTILITY POLES: WITH SPECIAL REFERENCE TO THE ROLE OF TERRITORY AND RESONANCE

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Five genera in the family Picidae are mainly responsible for damage to utility poles. These genera are *Melanerpes*, *Centurus*, *Dryocopus*, *Colaptes*, and *Dendrocopos*. Although several of these genera are represented by species in widely scattered parts of the world, including the northern and southern hemispheres, damage to utility poles, from information available to me, is restricted to the northern hemisphere. Only a few species in the genera involved damage poles, and few, if any, of these species are destructive throughout their respective ranges.

Turcek (1960), on the basis of correspondence and his observations, as well as sources from the literature, delimits the areas of woodpecker attack in Europe and Asia. It isn't entirely clear, however, whether he has found woodpecker damage to poles to exist only in countries specifically mentioned, or if he implies wider occurrence when he states in his summary that "damaged wooden poles are found throughout the whole Holarctic region." Old World countries specifically reported by Turcek to have this problem are Sweden, Finland, Czechoslovakia, Hungary, the U. S. S. R., and Japan. Genera involved are *Dryocopus* and *Dendrocopos*.

Woodpecker attack upon utility poles has probably been better documented and known for a longer period of time in North America. During the last century, Sennett (1879) commented upon the severity of attack in south Texas. Many others took note of damage by woodpeckers during the early days of the communications industry when most poles carried telegraph wires.

Not until 1911 was the problem seriously diagnosed by researchers. This year was important for the appearance of three papers: one on the damage caused by woodpeckers (McAtee, 1911), one on the food of woodpeckers (Beal, 1911), and one on the effect of woodpecker damage to pole strength (Weiss in McAtee, 1911).

No solution to the problem appeared during the early part of the century. Apparently in this day before laws protecting woodpeckers and other birds, the chief recourse was in shooting the offenders. McAtee, although noting that creosote as a pole preservative did

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nothing to deter woodpeckers, was, nevertheless, hopeful that a preservative would finally be found that would have a repelling effect. This hope of McAttee's has not yet seen fulfillment. On the other hand, two helpful methods of pole protection have appeared within recent years. Rush (1953) has described a method of covering poles with steel wire mesh which was said to be 95 percent effective in stopping damage to poles where first used in Louisiana. Dennis (1963a, 1963b) has described the application of a chemical taste repellent that may be applied by brush to the outer surface of poles, and which has been made available commercially to utility companies by Koppers Company, Inc.

Seven species of woodpeckers are mainly responsible for pole damage in North America. The Ladder-backed Woodpecker (*Dendrocopos scalaris*) of the Southwest has the habit of choosing the crossarms for its special place of attack. The bird begins drilling near the end of the crossarm, and always on the underside. Crossarms on smaller poles are rarely neglected where this species is common; on the other hand, the larger crossarms of transmission poles are almost never attacked. While holes are frequently begun in both crossarms and poles, only a few are completed as roosting or nesting holes. Either the bird leaves its work and moves elsewhere, or, in other instances, is too energetic and widens its crossarm hole to the extent that "windows" have been formed in the sides and a hole punched through the roof. Creosoted pine fenceposts are also utilized by these woodpeckers, and to a much greater degree than is the case with mesquite (*Prosopis juliflora*). Fenceposts of redcedar (*Juniperus virginiana*), widely used within the Ladder-back's range, are scarcely touched at all.

The Golden-fronted Woodpecker (*Centurus aurifrons*) is seen on utility poles in South and Central Texas much more often than the Ladder-backed. Although frequently encountered nesting in cavities on utility poles and characteristically in holes near the top, the Golden-fronted, for its numbers, is probably much less destructive than the Ladder-backed. Much of the time spent on poles seems to be in "loafing". From the observations I have made in Texas, I am inclined to believe that many times the Golden-fronted appropriates holes that have already been made by Ladder-backed Woodpeckers. These holes, whether in the pole or the crossarms appear to be enlarged by the Golden-fronted to a size suited to its roosting or nesting needs.

The Red-headed Woodpecker (*Melanerpes erythrocephalus*) also has the habit of "loafing" on poles. Only now and then does this species indulge in heavy excavating. When this occurs, holes are mostly made near the top of the pole. Where abundant, the Redhead may cause considerable damage to poles. In any locality the Red-head population may shift or change drastically. At present this species is not common enough in the northeastern states to be a problem on utility poles, but damage is locally severe in parts of the South and Mid-west.

The Acorn Woodpecker (*Melanerpes formicivorus*) is another species that spends a lot of time on utility poles. Its presence can scarcely be attributed to "loafing". Like the Ladder-backed, this species is continually active, and if not drilling large holes, it is making small ones. The large holes are for roosting and nesting, the small ones for storing acorns. Holes for receiving acorns are drilled in fence posts, utility poles and crossarms, sides of wooden buildings, and tree trunks, and sometimes in such profusion that an entire pole or tree trunk will be perforated from top to bottom. Damage to utility poles may be quite severe locally.

The Flickers (*Colaptes auratus* and *cafer*) cause damage to poles throughout much of their ranges which embrace most of North America. Damage seems to be most severe in the Province of Quebec, parts of our Northeast, and in the Great Plains region. Although more damage seems to take place in open country than within well wooded districts, this does not necessarily represent an adaptation to absence of suitable natural sites. Farley (in Bent, 1939, p. 269), writing of flicker damage in northern Alberta, states that even where there are many suitable nesting trees and stubs, utility poles are frequently used for nesting. Besides making nesting holes, which are characteristically near the ground (often as low as four or five feet), Flickers also do a certain amount of damage through apparent search for insects. This damage consists chiefly in the widening of existing checks and holes.

Forty years ago, at the time McAtee was writing of pole damage caused by woodpeckers, no one suspected that a seventh woodpecker, much larger and more destructive than any of those mentioned, would be on the scene in another twenty years. Early in this century, the Pileated Woodpecker (*Dryocopus pileatus*), seemed to be doomed to possible extinction because of its seeming inability to adjust to shooting pressure and change in habitat. Around 1920 there were slight indications that the Pileated had passed its lowest ebb and was beginning to adjust to the changes of civilization (Griscom and Snyder, 1955, p. 152). There seems to be no exact information as to when Pileated Woodpeckers, emerging from near extinction, first began to attack poles. Utility companies in the Deep South seem to have first experienced damage by this woodpecker about twenty-five years ago. Frings and Frings (1963) state that in 1930 this species was still hard to find in Pennsylvania, but that "by the 1950's, the power company in central Pennsylvania was fighting a losing battle to save its power poles from this bird."

The chief centers of Pileated damage today are in the southern states bordering the Atlantic and Gulf of Mexico, or from eastern Texas to southern North Carolina. Severe damage is also known from several other southern states and from Pennsylvania. Highly local damage occurs in New England, Quebec, Ontario, and over much of the Mid-west. Recently reports of severe damage have been received from western Minnesota where range expansion has taken place in recent years. I have not heard of any reports of damage taking place within the western range of the Pileated west of the Great Plains (for woodpecker ranges see Fig. 1).

There are a number of distinguishing characteristics to Pileated work on poles, and both in location and design this work is quite readily distinguishable from that of other woodpeckers. Mid- and upper-mid-portions of poles are most susceptible to attack. Ordinarily the bird pays little attention to the top portion of the pole, or roughly the part above the crossarms. And again, seldom is the lower ten or fifteen feet of the pole damaged. This lower portion, however, may in some instances become subject to damage when the vulnerable mid-portions of the pole are screened with protective steel mesh (hardware cloth).

Pileated work is to be distinguished from that of other woodpeckers in being more angular in outline. While seldom is a wood-

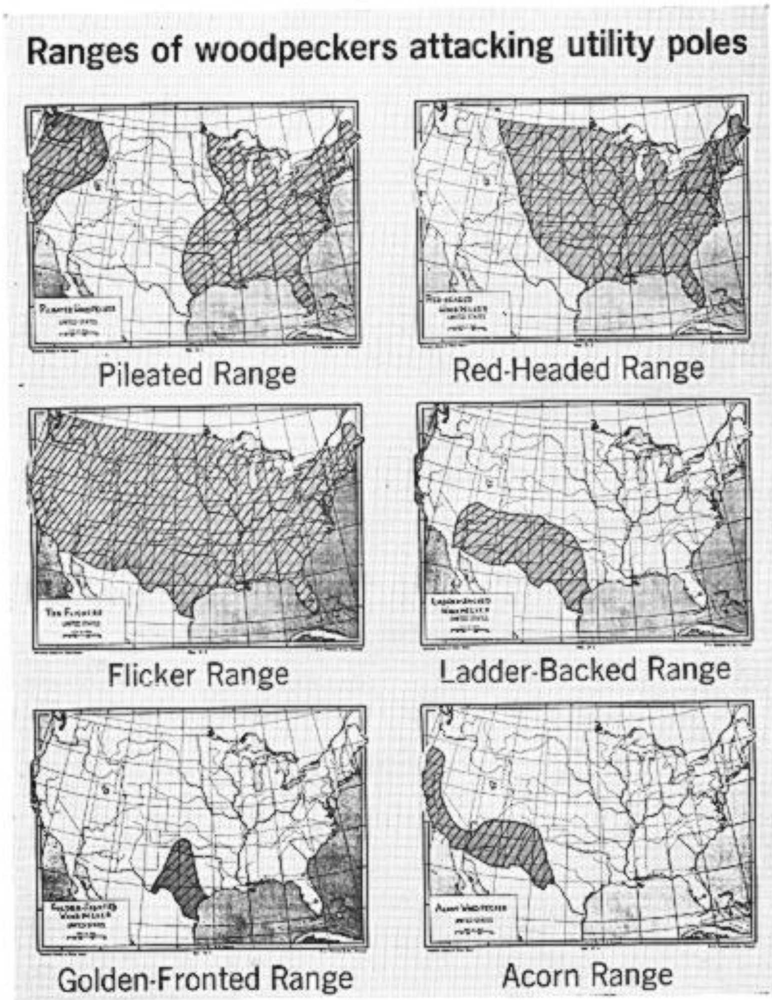

FIGURE 1

pecker's hole perfectly round, early Pileated work tends to be conspicuously squarish in outline. As a hole deepens, it tapers to a point, and thus the four sides tend to take on the shape of four triangles. Thus, looked at from the outside, such a hole has the appearance of an inverted square pyramid. Rarely does the bird achieve perfect symmetry. Sometimes the sides tend to be quite rounded, and whenever the cavity is deepened to the point where it seems to be becoming a roosting or nesting hole, the angular proportions are likely to be lost as the hole is widened. In fact, roosting and nesting holes can usually be recognized from other Pileated work by their roundness.

By far the largest number of holes a Pileated woodpecker makes in a utility pole are of the square pyramid type. Such holes terminate after going varying distances into the pole, and unlike roosting and nesting holes, they do not turn downward once the center of the pole has been reached. Not infrequently there will be a whole series of such holes, one almost equi-distant above the other and arranged vertically in a straight line on the same face of the pole.

Roosting and nesting holes are distinguished by their large size. The entrance is generally between four and five inches in diameter. The opening, as a rule, extends some nine inches into the heart of the pole. After reaching this depth the bird works downward to excavate a conical shaped cavity with a depth from top to bottom of 14 to 24 inches. Roosting holes are used year after year, while nesting cavities, in trees at least, are abandoned and usually not returned to once the nesting season is over (Bent, 1939, pp. 166, 170, 178 and Hoyt, 1957). But it appears that nesting sites are sometimes used for roosting holes (Brooks in Bent, 1939, p. 189). Many Pileated cavities I have examined in poles that have been removed from service showed signs of having been widened with each season's use until only a thin shell of the outside pole was left. Sometimes this shell was only about one inch in thickness.

Still another characteristic of the Pileated is the habit of attacking new poles. Often attack begins before the wires are strung and the pole is in actual service. This does not necessarily mean that it is the newness of the pole *per se* that stimulates attack. Even an old pole that is placed in a new situation may be attacked. More will be said of this habit later as it affords an important clue to the reason for Pileated attack.

Pileated attack is almost entirely confined to larger poles (usually transmission poles), and losses are particularly severe not only because of the greater cost of transmission poles but because attack upon such poles often takes place in remote, relatively inaccessible areas. The cost of replacement, therefore, is likely to be many times the cost of the pole.

The experience of Gulf States Utilities of Beaumont, Texas—a company that suffers severely from Pileated damage—may be cited as an example of damage costs to a company that has many transmission lines through heavily forested country in the South. An official of this company writing to Koppers Company of damage between April 1, 1959 through March 31, 1960 states:

"We estimate that about $69,000 was spent on repairing holes in wood poles, about $94,000 was spent to install hardware cloth on the poles that were repaired, and about $28,000 was spent to replace poles that were so badly damaged that repairs were not possible. This is a total of $191,000 spent on poles damaged by woodpeckers in the twelve month period shown. Included in this total was the replacement of about seventy poles . . . In the twelve month period shown our Aerial Patrol Report showed new attacks on 2,360 transmission poles."

Apparently no one has estimated the total cost per year of woodpecker damage to the utility industry. It is doubtful if there are enough figures available to permit even a rough approximation. It should be noted, however, that damage is uneven in distribution. The southeastern states are particularly hard hit because of extensive damage by Pileated and Red-headed Woodpeckers and occasional damage by the Yellow-shafted Flicker (*Colaptes auratus*). But even in this part of the country there are many companies that experience little, if any loss. Damage is widespread in Texas, and locally severe in southern California. Other centers of damage have already been noted. The Pacific Northwest is the only very large geographical region within temperate North America where the problem seems to be virtually non-existent.

UTILITY POLES VERSUS DEAD TREES

Before an understanding can be had of the reasons woodpeckers attack poles, something should be known of the characteristics of the pole and how the pole differs from the normal roosting, nesting, and feeding site of woodpeckers—the dead or partially dead tree. First of all, it may be stated that the dead tree has been subjected to a natural curing process of sunlight, air, and moisture. The utility pole, on the other hand, is a green tree which has been cut, trimmed, removed from the forest, debarked, seasoned, and then subjected to any one of several preservative treatments. The order in which the potential utility pole receives these attentions may vary somewhat, but in the end the utility pole is a product quite different from its counterpart, the dead tree.

Aside from the differences mentioned from cutting to curing, there are five important ways in which the utility pole may be enough different from the dead tree to cause it to be either more or less attractive to woodpeckers. These differences will be discussed briefly before reasons are advanced for woodpecker attack upon poles.

1. *Kind of wood*

Dead trees, it scarcely need be said, are representative of all of the many living trees to be found in a region. Sometimes there is a dominance of dead trees of one kind—perhaps because of the selectivity of fire, insects, or blight. Where similarity in species occurs there would be a likeness to the utility pole. All of the utility poles in a line are generally of the same wood. Only a few woods are common enough to use as utility poles, and, at the same time, have the necessary characteristics of straightness and durability.

The kinds of trees that furnish wood for pressure treated poles are shown below together with the percentage total of each produced in 1960.

Southern Pine*	74.2
Western Red Cedar (*Thuja plicata*)	6.2
Douglas Fir (*Pseudotsuga taxifolia*)	6.0
Lodgepole Pine (*Pinus contorta*)	5.5
Jack Pine (*Pinus banksiana*)	2.9
Norway Pine (*Pinus resinosa*)	1.8
White Cedar (*Thuja occidentalis*)	1.4
Western Larch (*Larix occidentalis*)	.9
Ponderosa Pine (*Pinus ponderosa*)	.7
Other	.4

2. *Imperfections*

Utility poles are selected from trees that are as nearly as possible free from blemishes and imperfections, particularly ones that might affect structural strength. The process of securing sound, defect-free poles does not end with the cutting of the tree. At several stages before the pole reaches its destination it may be inspected for hidden defects or injury that may occur in handling. By the time a pole is in the hands of the user it should be free of any but minor defects or weaknesses.

Assuming that the inspector and the producer have performed their services adequately, a new pole will be free of serious cracks or breaks, insect infestation, and decay. This, of course, is in marked contrast to the dead tree which is invariably invaded by insects and decay organisms. After a pole has been in service for some time, it may become more like a dead tree in that it may have become somewhat subject to insect infestation and decay. The age at which such infestation begins to take place depends upon a number of factors. Most important to the longevity of a pole is adequate treatment with preservative at the time of manufacture.

3. *Size*

The dimensions of a utility pole are subject to rigid specifications. Poles come in certain class sizes which are specific in respect to length and circumference. Taller poles, which are used to carry high voltage power, are called transmission poles. Lower voltage, such as that which is brought to individual homes, is carried upon distribution poles. Similar in size to the distribution pole, but on the whole somewhat smaller, is the pole that carries communication wires of the telephone and telegraph services.

Sometimes communication wires are not on separate poles but

*Grouped under Southern Pine are Long leaf Pine (*Pinus palustris*), Shortleaf Pine (*Pinus echinata*), Loblolly Pine (*Pinus taeda*), Slash Pine (*Pinus caribaea*), and Pond Pine (*Pinus rigida serotina*).

are attached to the same poles that carry electric power. However poles may be used, they differ from dead trees in being of standard size; hence it is common to find all of the poles in a line to be of uniform height and closely approximating each other in other dimensions.

4. *Preservative*

Somewhat over 65 years ago no pressure-treated poles were being produced. Utilities had to rely upon woods that were to some extent naturally resistant to decay and insect attack. These included white cedar, redcedar, cypress, and chestnut. In order to broaden the supply and extend the service life of poles, utilities at first turned to woods that could be preserved to the extent of having the butt or base dipped in preservative. This method did not provide adequate protection, however. Poles needed deeper penetration of the preservative—something that was accomplished by the end of the last century by means of pressure-treatment.

The pressure-treating process with most woods consists essentially of first steaming poles at high temperature in a pressure cylinder. A vacuum is then drawn to remove excess moisture. The cylinder is then filled with compressed air. Some of this pressure penetrates deep into the cells of the wood. The preservative is then introduced into the cylinder without breaking the pressure. The air and preservative is held for a period of time under pressure, then the pressure is released and the excess preservative, expelled by escaping air, is drained off.

About 69 percent of the treated poles being produced in this country today are pressure-treated with creosote. Another 31 percent are treated with pentachlorophenol (penta) in petroleum. A combination of creosote and penta is presently gaining in favor.

A normal impregnation of creosote is in the neighborhood of eight pounds per cubic foot. The depth of penetration varies considerably, but on the average is between one and four inches. The heart of the pole, therefore, is normally free of preservative. Penta at a level of five percent is generally incorporated in a petroleum solvent. A standard treatment is eight pounds of this solution per cubic foot. As with the creosote treatment, only the external part of the pole is penetrated by preservative.

Pressure-treatment with preservative, whatever the chemicals or process, makes for a very striking difference between the utility pole and the dead tree.

5. *Attachments*

Turning to crossarms, insulators, and conductors, the most important appendages of the utility pole, it would seem that in these there is a drastic departure from the dead tree. Yet, if such appendages are considered as analogous to branches of a dead tree, there is actually a striking similarity. In the crossarm, for example, there is a close counterpart of the limbs of a dead tree. And just as some dead trees are devoid of branches and others have many, so are utility poles similarly fitted with crossarms. Very simple power and communication systems may not require a crossarm at all. Attachments are made directly to the pole. But as voltage is increased and communication lines added, the crossarm becomes essential. With high voltage, conductors must be widely spaced and this calls for a correspondingly long crossarm. Numerous communication wires are accommodated best by using a number of crossarms.

In addition to crossarms, the utility pole may have secondary appendages in the form of wooden or metal braces. Braces are supports that hold the crossarms more securely in place and which in some types of construction may provide support between paired poles. Paired, or even triply or quadruplely arranged poles, are to be found in transmission line construction. The two or more poles in a structure are attached together by means of a common crossarm system, and often with additional strength supplied by braces.

REASONS FOR WOODPECKER ATTACK

Utility engineers and others have not been at a loss to find plausible reasons for woodpecker attack upon utility poles. Of the many reasons advanced, some can be rejected with little or no hesitation, others call for careful scrutiny. Yet with every reason that has come to my attention there are elements of sound observation and knowledge of woodpeckers. The problem seems to be largely one of putting many diverse arguments into proper perspective. But what may be the proper sequence of reasons for, say, the Pileated Woodpecker, does not necessarily hold true for each of the other woodpeckers involved in pole damage. Present emphasis will be upon the Pileated Woodpecker. Reasons for attack can conveniently be placed under five headings. No effort has been made to place these headings in order of importance.

1. *Resonance*

The acoustical properties of the pole have long been thought to play an important role in woodpecker damage. Utility engineers are among those who are apt to attach particular importance to theories involving acoustics and resonance. They are encouraged in their viewpoint by the seeming attraction the woodpecker has to any surface that resounds to the tapping of its bill. It would be an unobservant maintenance man or engineer who on a spring day did not see a woodpecker drumming upon an insulator, a metal attachment, or a part of the pole. The more discerning observer will note that there often seems to be a correlation between woodpecker damage to the pole and areas on the pole that are apt to be more resonant than others. Sometimes this is seen in holes that are concentrated near metal attachments; for example, a metal plate that binds a wooden brace support to the pole proper. Or again, on examining a pole that has been removed because of Pileated damage, an engineer may note that many, if not most of the holes the bird has made, are to small internal cavities in the pole. These cavities are frequently natural imperfections in the wood known as shakes or ring separations. If they do not exceed 1/16th of an inch in width and are not greater in extent than one-half the diameter of the top of the pole, shakes are not over-ruled by the pole inspector. There are few poles that do not have these small internal separations. Also internal cavities take another form in the narrow hollow pith centers to be found at the heart of occasional poles.

The common habit of woodpeckers to drum upon resounding surfaces such as metal gutters, tin roofs, antennas, and hollow trees should not be interpreted as a behavior pattern that is very likely to lead to the excavation of a hole. Drumming in the songless woodpeckers is the counterpart of song so conspicuous in many families of birds. Yet it is significant in the case of certain of the destructive woodpeckers that the same kind of hollow sounding places on utility poles that serve as drumming sites also seem to be selected for destructive hole drilling. This seems to be particularly true of the Ladder-backed Woodpecker and perhaps also true of the Flickers and the Golden-fronted Woodpecker. Almost any hollow sounding-board, such as a site where there is a metal attachment on a pole or crossarm, seems sufficient to trigger either drumming or destructive drilling in the Ladder-back. Countless wooden posts bearing metal signs are also drilled by the Ladder-back, and the drilling always takes place on the opposite side of the post from the sign and at the point of maximum resonance or vibration.

The Pileated Woodpecker, on the other hand, seems to take much less notice of situations of this kind. I have never observed any tendency on the part of this species to drill at drumming sites. Its preoccupation, as already noted, is with shakes or ring separations within the pole: a topic that will be discussed under "mistaken activity".

Finally under resonance, it is often supposed that the hum or buzz of the wires, transposed to the pole, provides an acoustical basis for attack. The woodpecker, so it is believed, mistakes the sound for insect-life within the pole and hence a reason for its attack. This theory can be demolished on many scores, but perhaps it should suffice to say that severe attack often occurs on newly placed poles before the wires are strung.

2. *Habitat considerations*

The viewpoint that alteration of habitat has something to do with pole damage is as strongly entrenched in the thinking of utility engineers and others who have investigated this problem as are the various theories about resonance. The opinion most often heard is that woodpeckers, because of modern forestry and clean-up practices, are forced to find substitutes for dead or partially dead trees in utility poles. This theory implies, therefore, that with a reversal of clean forestry practices, and perhaps with the erection of bird houses, woodpeckers would leave off their destructive work. McAtee (1911) suggested placing bird houses along utility lines. I have never heard of this last practice being tried. Perhaps it was realized that of the destructive woodpeckers only the Flickers commonly make use of bird houses.

Though bird houses do not seem to have been tried, a somewhat similar "placating" technique has been employed widely. Instead of discarding woodpecker damaged poles, many companies have made a practice of placing a damaged pole in close proximity to the new pole that is being used as a replacement. It seemed reasonable to believe that if birds were hard pressed for cavities they would stay with the hole-riddled old poles and not attack the new poles. Results in perhaps nine out of ten experiments of this kind have been disappointing. The woodpeckers, responding not to their old cavities, but to the exact locations where the old holes had been, almost invariably set about drilling holes in the new poles.

These experiments seem to suggest that it is not a shortage of natural sites that causes woodpeckers to damage poles. And, in fact, it has been my observation, in examining woodpecker damage in many states and in several provinces of Canada, that damage is most severe where habitat is richest in dead trees and the kind of growth generally that is suited to the needs of woodpeckers. A few examples will serve to illustrate this.

A power line in a heavily wooded area near Livingston in eastern Texas came under heavy Pileated attack almost as soon as the poles were placed. Forest growth consisted of an inter-mixture of mature pines and hardwoods. Not only was there a natural abundance of dead trees and dead limbs, but many oaks were dead as a result of having been girdled in order to promote the growth of pine. In a second region in eastern Texas near Houston, a four-mile-long stretch of transmission line in operation for 17 years has experienced numerous pole losses because of severe Pileated attack. This line was through a heavily wooded region of pines and hardwoods. Dead trees were plentiful.

Possibly the most striking example of the relationship between dead trees and damage to utility poles is afforded by the experience of an electric power company in Indiana. In a part of their system they had experienced no woodpecker damage to their lines until the creation of a large reservoir. With the appearance of hundreds of dead trees in flooded forested land at the edge of the reservoir, woodpecker damage began to be noticed for the first time on lines in that vicinity. The Pileated Woodpecker was said to be the species involved.

Many other illustrations of the same kind could be given, but perhaps enough has been said to indicate that the relationship of habitat to pole damage has been misunderstood. An alteration of habitat that saw a drastic removal of dead or dying trees would be expected to result in an overall reduction in the woodpecker population. The reduction might be particularly pronounced in the case of species, like the Pileated, that are highly dependent for food upon the kinds of insects that live in decaying wood.

If the habitat change is drastic enough to result in the replacement of woodland by, say, cultivated fields or grazing land, woodpeckers may vanish altogether. I have seen many cases where this has happened in the lower Rio Grande valley and elsewhere in south Texas. The clearing of chaparral growth, that once supported sizable populations of Golden-fronted and Ladder-backed Woodpeckers, resulted in the complete elimination of these two woodpeckers. Birds did not seem to show any tendency to adapt to roadside utility poles or any remaining roadside vegetation. Under such severe circumstances both woodpeckers and woodpecker damage to poles disappeared.

The two woodpecker species just mentioned, on the other hand, are able to adapt to some degree to the habitat conditions of towns, tree-planted yards, and citrus groves. In such artificial surroundings they are much less common than they are in natural chaparral, and they do not, so far as I have observed, attack utility poles.

Although there may be exceptions, attack upon utility poles is to be correlated with population density. In the case of the species under discussion, little or no attack is likely when the population is below an undesignated saturation level. When numbers are above this theoretical level, attack may be anticipated. Heavy population density may be the result of an actual increase such as is likely to occur when food and nesting conditions are improved by the appearance of large numbers of dead or dying trees. Or again the greater density may be the result of pressure by man upon habitat. With the gradual diminution of favored habitat that takes place with the construction of roads, power lines, flooding of valleys for reservoirs, and the like, woodpecker populations are crowded into more and more restricted areas of remaining good habitat. The process may not be so devastating or sudden as to cause an over-all reduction in the population. But this process, just as in the case of an actual increase in population, does result in the compressing of individual areas or territories that mated pairs or family groups of woodpeckers defend against others of their kind. This in turn results in more strenuous competition for food and for roosting and nesting sites. And, as I shall endeavor to show, competition is an important factor in woodpecker attack upon utility poles. But first something needs to be said about the role that territorial defense plays in the lives of the woodpecker species that are responsible for pole attack.

3. *The role of territory*

As defined by Pettingill (1956) "territory is usually established by the male of the species and defended by him against other males of the same species. The female may or may not participate in territorial defense . . . Territory itself is the purpose of the defense, not the sex-partner, nor the nest and young. Competition for territory is theoretically intraspecific, not interspecific."

Pettingill defines two main categories of territory: (1) the breeding territory, and (2) the non-breeding territory. With permanent residents, the same territory that was defended during the nesting season may also be defended during the winter. Sometimes in permanent residents the winter territory is not synonymous with the breeding territory. But in the Pileated Woodpecker, according to Hoyt (1957), "the nest is usually placed within the boundary of the winter range and not far from the winter roosts."

The Red-headed Woodpecker, usually thought of as a permanent resident, defends a territory against others of its kind during the breeding season, but tends to become gregarious during the rest of the year. With the failure of the staple winter food supply of mast in the form of acorns or beechnuts, the Red-head can be expected to emigrate in flocks to regions where favored food is more abundant; thereby this species may become a migrant during some years.

The two Flickers are also gregarious during the non-breeding season. There is a pronounced migration southward in winter by birds from more northern states and from Canada. There seems to be little information to indicate whether or not Flickers that nest in more southern states are permanent residents. In any event, Flickers do defend territory during the breeding season.

The most gregarious and social of the woodpeckers under discussion by far is the Acorn Woodpecker. Even during the breeding season individual pairs show little disposition to defend territories against others of their kind. Unless there is a drastic shortage of food which would cause birds to emigrate, the Acorn Woodpecker remains permanently established in the same feeding and nesting grounds year after year. Vigorous defense is made against mammals and other birds that may show a tendency to interfere with its food supplies.

The Ladder-backed and Golden-fronted Woodpeckers that together occupy overlapping ranges in Texas are permanent residents that show a strong tendency to defend both breeding and winter territories. Whether the two territories are synonymous is apparently not known.

Whatever the individual differences regarding migration habits and defense of territory among the woodpeckers in question, all seem to share the habit at some season of guarding territory against intrusion. Guard-duty, as it might be called, is performed from a tree, pole, or post in the open that allows good visibility in every direction. When a trespasser is sighted, the defender can be expected to make a display of force. The usual reaction is to fly boldly at the intruder. Swooping down from a higher level, as a rule, and with all the confidence of territorial ownership at its disposal, the defending bird is almost invariably the victor when opposing another of its kind. The defender, in turn, may shortly choose to be an aggressor itself. Throughout the nesting season, and again in winter in the case of those woodpeckers that establish winter territories, activity of this kind goes on more or less continuously and usually without harm or serious struggle on the part of any of the participants.

With crowding that comes with a population increase (or reduction in suitable habitat), territorial conflict becomes ever more intense. To provide a hypothetical example, let us suppose that favorable conditions have permitted Pileated Woodpeckers to reach saturation numbers in a heavily wooded area. Territories of individual pairs are contiguous and have been narrowed to the degree that seasonally there is almost constant territorial conflict for food and for roosting and nesting sites. A new element is introduced when an electric power company builds a transmission line through this woodland. With the construction of a wide right-of-way, numerous trees that were useful for feeding purposes or for roosting and nesting have been removed. It may be expected that certain pairs of woodpeckers will have their territories bi-sected by the right-of-way. Other pairs will be left with most of their territory on one side of the right-of-way and perhaps only a few acres on the other side.

The reaction of birds whose territories have been disturbed can be predicted. Almost immediately they will begin to spend a large share of their time on the newly erected poles: this would be particularly true if the poles were placed at a time of the year when territorial competition was keen. In the Pileated Woodpecker there is a period of intense competition in early fall when roosting sites are selected. As food becomes less plentiful in late fall, new competition may arise over limits of feeding grounds. A new element of competition arises in late winter as pairs select nesting sites. Competition can be expected to continue through the period that the nesting hole is excavated and on into the nesting season.

We may conveniently assume in our hypothetical example that the new pole line has been constructed at a time when birds are competing with each other for roosting or nesting sites. The new poles thus not only become watch posts from which to guard territorial boundaries but potential sites in which to excavate needed cavities. The transmission pole ideally fits both purposes. Generally poles are between 55 and 65 feet in height—high enough for birds clinging to the upper portions to watch in all directions. The transmission pole is likewise of a height and diameter that corresponds favorably with any potential nesting or roosting tree in the vicinity.

The woodpecker presumably is incapable of reasoning out all these advantages for itself. Its original presence on the pole was an instinctive reaction of self-preservation. The first few blows of its bill upon the blackened creosoted surface of the pole may have been a way of letting other woodpeckers know of its territorial claim. Only when the woodpecker has received the proper internal glandular stimulus at the right time of the year can it be expected to initiate work upon cavities that have a functional value.

With completion of roosting and nesting holes and territorial claims firmly established, destructive work along our hypothetical pole line can be expected to lessen. It was my observation in eastern Texas that the heaviest damage to a utility line occurred during its first year in service. In one instance, I noted light damage occurring along a line that had been in service for four years. When the same line was visited a year later, no Pileated Woodpeckers were seen on the poles and damage had fallen off to almost nothing.

Unfortunately maintenance crews can seldom wait until this happy stage has been reached. Poles that are badly damaged are no longer capable of safely supporting the crossarm structure with its insulators and attached cable. At no little expense such poles must be removed and sound poles put in their place. This is an activity which the woodpecker is sure not to overlook. Roosting and nesting sites have been destroyed, and it may be conjectured that new untouched poles in some way represent an invitation to woodpeckers in adjoining territories to trespass.

The pole replacement program like the original construction of the line sets off a round of destructive activity. Because of the strong site tenacity that seems to be inherent in all woodpeckers, the new poles come under attack while older poles escape. As mentioned earlier, it must not be thought that newness *per se* plays a part in this attack. There are many examples, such as at the western limits of the Pileated's range in the East, where through range expansion, the species has been encountered along pole lines for the first time. Where numbers have reached high enough levels, attack has taken place on existing lines regardless of the age of the poles. This attack has occurred, of course, without there necessarily being the dislocation that attends the construction of a new pole line. But whether the attack is on a new line or an old one, the same population pressures presumably are at hand that cause birds to seek out certain poles for lookouts and for roosting and nesting holes.

4. *Mistaken activity*

Invariably in any discussion of the reasons for woodpecker attack upon poles, the supposition is made that the woodpecker is somehow fooled by the appearance of the pole or the sound within the pole. Reference has already been made to the baseless belief that woodpeckers mistake the hum from the wires for wood-boring insects. Turcek (1960) mentions that one of the suggested reasons for pole damage is that woodpeckers may be fooled by the darkness of the preservative impregnated wood of utility poles, to a degree that the darkness is mistaken for decayed wood. Turcek rejects this theory on the grounds that he has found untreated poles heavily damaged by woodpeckers. In this country, of course, damage to poles antedated the preservative treatment by many years.

While the theory that the woodpecker is fooled to some degree can lead to barren speculation, this idea must not be rejected altogether, and, indeed, in the case of the Pileated Woodpecker the theory provides a reason for a phenomenon that otherwise defies explanation. Jorgensen *et al.* (1957) comment upon a spherical type hole that the Pileated makes in utility poles and which is very rarely found in standing timber. The writers were unable to provide an explanation for this commonly made hole which they describe as the most destructive of any that the Pileated makes in utility poles.

Earlier in this paper, I described functionless holes made by the Pileated in utility poles, but I tended to regard these holes not so much as spherical but, in their early stages at least, as angular in shape. Characteristically these holes went deep into the pole and frequently terminated at a shake or pith cavity.

To get at the basic reason for these holes, or probings, there is a need to examine the problems that face woodpeckers in making their deeper penetrations. Universally woodpeckers, whether they are drilling in a dead or a still living tree, seek out sites where their work will be made easier by reason of internal decay or an existing cavity. Perhaps two Old World species provide exceptions. Turcek (1960) states that the Black Woodpecker (*Dryocopus martius*) and Great Spotted Woodpecker (*Dendrocopus major*) regularly excavate holes in sound, living trees. However, the one woodpecker species in North America that invariably builds its nest or roost hole in a living tree always chooses a tree infected with heart-rot. This bird, the Red-cockaded Woodpecker (*Dryobates borealis*) of the Southeastern pine woods, according to Wayne (in Bent, 1939, p. 74) and Steirly (1957) always chooses a living pine tree and one that is infected with decay internally.

The reason for this marked partiality by woodpeckers for dead trees or living trees with internal decay presumably lies in a physical explanation. Clinging to the outside of a tree (or pole), a woodpecker can put the full pendulum force of its head and neck behind each blow of the bill. There does not seem to be a wood hard enough to resist the blows of the woodpeckers that are structurally equipped for heavy excavating.

But as the woodpecker gets deeper into the hole it is excavating, its work becomes more difficult. Each chip knocked loose has to be picked up, taken to the entrance, and tossed aside. At the same time the movements of the bird become more circumscribed. There is no longer the same freedom to swing the head and neck like a pickax. Consequently the work becomes slower and more arduous. It is precisely for this stage of its work that the woodpecker has had the "foresight" so to speak to pick a site where internal decay or hollowness will come to its aid. By tapping with its bill, in the way we might tap a watermelon with our knuckles for ripeness, the bird sounds the site from the outside and determines exactly where to drill. A completely hollow tree is avoided because of the absence of a shelf on which to place the eggs; a solid green tree is avoided because of the already mentioned difficulties of excavating once the hole becomes deepened.

Hoyt (1950) describes the uncanny precision with which the Pileated Woodpecker taps colonies of carpenter ants in outwardly solid trees. Not only does this species never fail to uncover a colony once it has begun its work, but, according to Hoyt, the work is done with such accuracy that the Pileated always hits upon the exact center of the colony.

In light of what has been said about woodpeckers sounding for decay and hollowness before they begin excavating, it might be thought that utility poles—particularly new ones—would be almost immune from damage. The only hollowness presumably that a woodpecker might be expected to sound out in a new pole would be in the form of the small pith cavities and shakes. Such minor internal hollows are scarcely to be compared with the condition of a dead tree where typically the inside is alive with decay and insect galleries while the exterior may be relatively sound. It has been mentioned, however, that the Pileated Woodpecker apparently has the ability to sound out small cavities that may exist in new utility poles and that in many cases its excavations lead as far as a shake or pith center and go no farther.

The bird's behavior in this regard seems completely unintelligible unless considered in light of the previous supposition that woodpeckers are in some way fooled by the artificiality of the utility pole. It does not seem too farfetched to believe that the Pileated Woodpecker, in its search for internal hollowness or decay as an aid to excavation, is fooled by the presence of shakes and hollow pith centers. Not until the bird has bored through to such minor cavities does it apparently become aware of its mistake. Instead of insect galleries or rotten wood, the bird finds only a minute cavity that is of almost no advantage to it in its excavation of a roosting or nesting hole.

The bird may be expected to abandon this hole and start another at a point where again its soundings indicate hollowness. These probing excavations are not without a pattern. Frequently the bird will limit its diggings to one side of the pole, and, then, apparently after having exhausted all hollow soundings, will move to another side of the pole or to a new pole to recommence its operations.

Not only are holes frequently arranged in a vertical series, but certain altitudinal and directional patterns are to be found. Results of a survey of damage I made along a mile of transmission line in eastern Texas, show that of 177 Pileated holes, only four percent were in the lower third of the pole, six percent in the uppermost six feet, and the remaining holes were in the mid and upper-mid portions of the pole. Thus 90 percent of the holes fell within the altitudinal limits of 20 to 50 feet above the ground. A closely similar altitudinal pattern can be found wherever the Pileated is a problem to utility poles.

Turning to compass direction, there is a strong southerly orientation, many holes face to the east, and the remainder of the holes are well distributed throughout the points of the compass. In a sample of 142 holes in poles on mile long stretches of three transmission lines in eastern Texas, I found the following directional distribution:

Direction	*Number of holes*
S	50
SW	16
SE	10
E	19
NE	9
N	14
NW	15
W	9
	142

Bayard Christy (in Bent, 1939, pp. 176-177), writing of the nest holes of the Northern Pileated in natural timber, states that "the hole commonly, though not invariably, faces the east or the south".

Noting in his study of pole damage that woodpecker holes showed certain characteristics in regard to altitude and direction, Turcek (1960) came to the conclusion that if the cause of the damage were vibration or search for insects, holes would show a random distribution. But, inasmuch as holes conformed to certain altitudinal and directional patterns, he concluded that they were made for roosting or nesting. Not only were the holes at the equivalent heights that they would be in trees, but the shape of the entrances and the dimensions conformed to the roosting or nesting holes of the woodpecker species in question. Turcek thus has reached the same conclusion that I have regarding the basic reason for pole attack; namely, that the holes are intended as roosting and nesting cavities.

He does not, however, advance a very plausible reason for the presence of holes beyond the number needed for roosting and nesting. In Czechoslovakia he found from one to ten holes per pole, and adds that "if several holes are in one pole they are usually arranged vertically so that the oldest is the uppermost one". He interprets the vertical arrangement of holes and the order in which they are made to the tendency of the woodpecker to bore first in the upper part of the pole where it is "too thin" to accommodate a cavity of the size needed for roosting or nesting.

Turcek, therefore, also supposes that the woodpecker is in some way fooled or misjudges. But it seems more logical to me to believe that the woodpeckers observed by Turcek were fooled by the same kind of small internal cavities that I have suggested to be the object of initial attack by the Pileated. The birds presumably start their excavations near the top of the pole because of better visibility in watching for trespass.

Turcek does not say how many functionless holes are usually made before a roosting or nesting hole is completed. In the Pileated, I found that on the average there are 20 functionless holes to every hole that serves a purpose. In surveys of three transmission lines near Houston I found only 15 roosting or nesting holes in a total of 302 holes counted Thus, so far as I could determine by examination through binoculars from the ground, five percent of the holes made were completed and had served or were serving as roosting or nesting sites.

I obtained exactly the same percentage of roosting and nesting holes in surveying Ladder-backed and Golden-fronted damage to poles in south Texas. In my south Texas survey I not only relied upon observation from the ground, but through the cooperation of the electric power company with lines in that region, I obtained the services of a man who climbed the poles and measured all woodpecker holes in 50 poles and 60 crossarms. Of the 117 holes counted and measured, only six were roosting or nesting cavities.

I have not made similar surveys of damage by other species of woodpeckers. But my general impression in viewing the work of Flickers, Red-headed Woodpeckers, and Acorn Woodpeckers, in their respective ranges, is that they too drill large numbers of functionless holes in utility poles and that completed roosting or nesting holes constitute only a small fraction of the total.

The same species may also drill a number of holes in trees before they finally select the proper hole for roosting or nesting. But, unless the woodpecker is dispossessed by another hole-nesting bird, such as a Starling (*Sturnus vulgaris*), the number of "test" holes is likely to be small. The life histories of the Pileated and its several races in

Bent (1939) fail to show a notation of anything more than one or two false starts before the final hole is excavated.

The woodpecker that begins an excavation in a utility pole apparently isn't easily discouraged. Though it has probed every site where its tapping has indicated any sign of internal hollowness, and without success, it nevertheless finally settles down to persistent work at one place and until a cavity is completed. There is little evidence to indicate that a bird that has selected a utility pole ever gives up and goes to a dead tree instead. The basis of this persistence seems to lie in site tenacity. Once psychologically ready to undertake nesting at a pre-selected site, there is little that will dissuade a woodpecker.

So strong is this tendency to come back to exactly the same site that when a pole containing a nesting hole is changed out and replaced by a new pole, a woodpecker will go to almost exactly the same place on the new pole to commence hole making anew. The story is told by a utility official in south Texas of a maintenance engineer who accused his foreman of not having changed out a woodpecker damaged pole because the hole was still there and the bird still there. The foreman was confident that the pole had been replaced, and when he checked he found that the woodpecker (either a Golden-fronted or Ladder-backed Woodpecker) had made a hole in the new pole at exactly the same place where the old one had been. Stories of this kind are frequent in utility companies that are troubled by woodpeckers, and they serve to emphasize the tenacity that woodpeckers show for any previously selected site.

5. *Insects*

The possible role of insects as a cause of pole attack has been variously interpreted. Hoyt (1957) supposes that Pileated Woodpeckers attack poles to get at carpenter ants (*Campanotus herculeanus*). Jorgensen *et al.* (1957) place little importance in the food-finding motive. They state that they found no evidence of carpenter ants existing in creosoted poles. They add that "many of the attacked poles treated with preservative only at the butt end did not contain ants or signs of other active insects." These observations were made during the winter season when Pileated attack was at its height, and when analysis of droppings indicated that birds were feeding chiefly upon carpenter ants. Turcek (1960), because of the pattern in which holes are distributed, finds no grounds for attack based upon food.

With new well treated creosoted or penta treated poles the probability of there being any internal insect infestation is so extremely remote that a discussion of this possibility scarcely seems needed.

In the steaming process prior to treatment, poles are heated to a maximum temperature of 259° F. This steam-heat treatment lasts for a period of 6 to 15 hours. A second heating occurs when the poles are impregnated with preservative under pressure. During this cycle temperature is maintained at about 200° F for a period of from about 2½ to 4 hours. The combined effects of heat and preservative toxic to insect-life would be expected to destroy any life that might be in the pole. Following the treatment process poles are stacked in yards to await delivery. Poles may remain in inventory for varying periods of time. Specifications of certain users call for delivery within less than 12 months. It seems highly unlikely that insect penetration could occur during the waiting period or even for several years after the pole has been in service.

Huffman (1960) states that carpenter bees "occasionally cause damage to wood in service" and may tunnel into "sound, and sometimes treated wood to deposit their eggs." He further reports upon damage by flatheaded pine borer beetles (*Chalcophora virginiensis*) to pine utility poles treated with creosote that were 8 and 11 years old, respectively. He considered this attack very exceptional. No details were given as to the amount of creosote present in the wood at the time this attack was discovered.

Quite a number of insects seek out utility poles as places to spend their periods of winter dormancy. Of the several ants, bugs, beetles, and other insects, only one seems to figure at all importantly in new poles. The paper wasp (*Polistes*) goes to any check, crevice, or small hole that may offer it shelter. In Texas it was a common experience to find these wasps emerging from their shelters on warm winter days. They would fly about for awhile and then return to the pole as the day advanced. Utility maintenance men were well acquainted with the wasps, and more than once I was told that wasps were more numerous in new poles than they were in old ones.

Pfitzenmeyer (1956), in reporting upon his field studies in Pennsylvania, states that in winter and spring the Pileated Woodpecker has the habit of enlarging crevices in utility poles in order to get at dormant paper wasps. Damage of this kind, he states, showed a rapid increase in spring. Pfitzenmeyer (1962, pers. comm.) further reveals that he obtained evidence of Pileated predation upon wasps in three ways: observation of feeding birds while he watched with the aid of binoculars, fragments of wasps in cracks and at the base of poles after the bird had left, and by examination of droppings.

These observations by Pfitzenmeyer are to be welcomed for the light they shed upon the reason for the oblong feeding cavities that are so conspicuous in poles that have been worked upon by the Pileated Woodpecker. It is not unusual to see checks as long as twenty or thirty feet that have been hollowed out at intervals along their entire lengths. This type of work, although quite spectacular in some instances, is nothing like as damaging to the pole as the several other deeper type of excavations that have been described. Other woodpeckers, as well, make feeding enlargements along checks. Small feeding cavities are especially common wherever Flickers do damage to poles.

How importantly paper wasps may figure in destructive work to poles may perhaps be judged by evaluating their place in the diet of woodpeckers. Beal (1911) in his exhaustive study of the food habits of North American woodpeckers, which was based upon the examination of 3,453 stomachs, groups main food items by the percentage taken. Hymenoptera, excluding ants but including bees and wasps, figure significantly only in the diet of one species that damages poles —the Acorn Woodpecker. A few are taken by the Red-headed Woodpecker, a minute quantity by the Yellow-shafted Flicker, and none at all are listed by Beal for the Pileated Woodpecker and the several other woodpeckers that damage poles. The percentage by total volume of bees and wasps in the annual diet of woodpeckers is shown by Beal as follows:

Lewis' Woodpecker	11.57%
Acorn Woodpecker	7.34
Yellow-bellied Sapsucker	2.64
Red-headed Woodpecker	1.63
Red-bellied Woodpecker	1.45
Downy Woodpecker	1.18
Hairy Woodpecker	1.00
Yellow-shafted Flicker	.04

On the basis of Beal's findings, there would be little reason to give significance to the paper wasp as a cause of pole damage. Food habits of birds change, however, and digging into utility poles for dormant wasps could be interpreted as a newly acquired habit.

Turning to older poles where weathering, gradual leaching out of preservative, and damage, such as that made by woodpeckers, makes for a more congenial environment, a greater role on the part of insects is to be looked for. To obtain a rough picture of the kind of insect life to be found in old poles, during the winters of 1961 and 1962, I collected specimens from poles that had been removed because of woodpecker damage near Houston. These specimens were sent to Dr. H. R. Burke of the Department of Entomology, Agricultural and Mechanical College of Texas, who kindly provided identifications. About 30 poles, ranging in age from 17 to 30 years, were examined. Listed below, starting with the most abundant form first and in descending order, are the groups represented in the collections:

Ants	*Formicidae*
Spiders	*Arachnida*
Wireworm	*Elateridae*
Darkling beetle	*Tenebrionidae*
Termite	*Isoptera*
Tree stink bug	*Pentatomidae*
Earwig	*Labiduridae*
Cockroach	*Blattidae*
Centipede	*Chilopoda*
Moth pupae	*Lepidoptera*
Cicada	*Cicadidae*
Fungus gnat	*Mycetophilidae*

The various insects and other arthropods listed were found in a wide variety of places—richest sources were old woodpecker holes, empty bolt holes, and the groundline where decay had set in. Termites were found only in decayed wood at the groundline. A tree stink bug (*Brochymena fariosa*) was a common inhabitant of empty bolt holes where it had obviously gone for its period of winter dormancy. Wireworms, earwigs, cockroaches, and centipedes were found only where decay was at an advanced stage. They were especially common in decay at the groundline and in the rotted out interiors of old woodpecker holes. Ants were often plentiful in decayed areas, but they were also found almost anywhere on the surface of the pole or in checks or small crevices. On the whole, ants, although I have listed them as the most common insect inhabitant of the old pole, seemed far less abundant than they are in dead trees or in rotting wood on the ground. Spiders shared many niches on the pole with ants, but unlike ants were not concentrated in any place in large numbers. Not only were spiders capable of finding shelter in empty bolt holes, old woodpecker holes, and deep checks, but they seemed able to exist in almost any minute fissure in the surface of the pole.

Whether any of the forms collected figure importantly in pole damage by the Pileated Woodpecker is not known. Of the groups listed only ants, *Elateridae*, and termites are specifically listed in any of the accounts I have seen of the food habits of the Pileated. An analysis by Beal (1911), based upon 80 stomachs, reveals that 72.8 percent of the diet consists of animal matter and 27.1 of vegetable matter. Ants make up 39.9 percent of the diet and constitute more than half of the animal food. No less than 2,600 ants were found in one stomach. Beal states that the ants were "mostly larger species and ones that live in decaying timber." The next largest animal food category consists of beetles; these make up 22.0 percent of the diet and were nearly all in the larval stage. Beal states that "they belong to the Cerambycidae, the Buprestidae, and the Elateridae, all of them wood-borers, with some Lucanidae and Scarabaeidae, many species of which breed in rotting timber."

Snyder (1948) provides added detail, based upon U. S. government wildlife collections. He points out that 28 of 113 Pileated Woodpecker stomachs examined contained termites. One stomach contained about 400 termites.

Food habits studies show that the Pileated obtains most of its animal food by excavating into well rotted wood. In parts of the country the Pileated is known as the log-cock; a name derived from the bird's frequent habit of descending to the ground and excavating rotting logs for the food to be found within. If the Pileated Woodpecker were visiting utility poles for this kind of food, the bird would pick old poles and would be apt to center attack at or near the groundline, where, as mentioned earlier, one of the greatest concentrations of invertebrate life is found whenever decay is present. Instead the Pileated does its most devastating work on new poles and attack is centered at middle and upper-mid levels. This is the very part of the pole where fewest of the forms collected were found. And finally attack is primarily directed at the heart of the pole, a part where there is a conspicuous absence of prey.

While there would seem to be only very limited reason for the Pileated to excavate into poles—old or new—for food, this species does nevertheless do a considerable amount of surface gleaning.

Anyone who has watched one of these birds on a pole for any length of time will see evidence of interest in prey on the surface of the pole or in easily accessible checks and holes. On one occasion, I watched a bird for about twenty minutes as it examined every crevice and hole as it carefully worked its way up and down and over several sides of a sturdy but partially woodpecker damaged utility pole. Frequently pausing and cocking its head with each pause, the bird seemed attentive to even the most minute kinds of insect life on the pole. Not once did the bird use its bill to drill or excavate into the wood; rather its activity was limited to picking small objects (possibly ants) from the surface of the pole or probing into cavities for prey of possibly a different sort.

There is also little evidence that Ladder-backed and Golden-fronted Woodpeckers resort to heavy drilling to obtain food on utility poles. Both of these species appear to do much less drilling in checks and crevices than the Pileated, and what food they find on poles is probably gleaned from the surface or procured with little difficulty from rotting cavities in old poles.

A special study was made of the food habits of these two species in relation to utility poles. Birds that seemed to have procured food on utility poles were collected under special permit and the stomach contents examined. Collecting took place during the winter and spring of two years, and was confined to several counties in south Texas. Animal matter was identified through the generous cooperation of Dr. Burke.

Of the 19 Ladder-backed Woodpeckers collected, no vegetable matter at all was found in any of the stomachs. Larvae of wood-boring beetles of the families *Cerambicidae* and *Buprestidae* made up one large element of the diet. Larvae of other families of the Coleoptera included representatives of the *Curculionidae*, *Bostrichidae*, and *Carabidae*. The other largest element consisted of Lepidopterous larvae. The family best represented was the *Phaloniidae*, small moths whose larvae are foliage feeders. Larvae of other small moths (*Pyralidae*) were also represented. Ants and spiders were also a significant item, but not as important in total bulk as the first two groups.

With the exception of ants and spiders, there seems to be little in the Ladder-backed Woodpecker's diet that might be attributed to utility poles. Certain of the lepidopterous larvae and larvae and adults of wood-boring beetles could conceivably have been obtained from rotting sections of very old poles. A more likely source would seem to be more customary sites in trees and logs.

Half of the diet of the Golden-fronted Woodpecker on the basis of 47 stomachs was found to consist of vegetable matter (fruits and berries) and the other half animal matter. Of the insect matter in the samples I obtained, virtually all can be classified as being obtainable without recourse to heavy excavating. Stink bugs (*Brochymena* spp.) of the family *Pentatomidae* found in six stomachs did, however, make up a conspicuous item of the insect food and it seems probable that these were obtained on poles. It has been noted that these bugs were found in winter in cavities in old poles.

Spiders made up another important item in the diet. These could have been obtained from surfaces of poles or from checks and old woodpecker holes. A third item of importance was the larvae of a small moth (*Melipotis* sp) of the family *Phaloniidae*. Larvae of these moths are foliage feeders on mesquite (*Prosopis* spp) and therefore not to be expected on utility poles. Other insect foods included darkling beetles (*Tenebrionidae*), hister beetles (*Histeridae*), ground beetles (*Carabidae*), snout beetles (*Curculionidae*), and a cicada (*Cicadidae*).

DISCUSSION

Taking the Pileated Woodpecker as my main example, excavation of roosting and nesting holes is the prime motive in pole attack. Turcek came to a similar conclusion in deciding upon the reason for attack by several Old World species. The utility pole has a special attraction because it is in an open lane through the woods where an established pair of woodpeckers can watch for trespass upon territory by others of their kind. A contributing factor, in some cases, is the disturbance caused by the clearing of the right-of-way. Territories of individual pairs are bisected and trees used for roosting, nesting, and procurement of food are removed. Such changes add to the rivalry that may already exist between competing pairs, and this, in turn, results in added significance of the utility pole as a lookout.

Only when populations are crowded is there such jealously over territorial rights. In many parts of its range Pileated Woodpeckers are not numerous enough to have closely bordering territories. Under such circumstances little attention apparently is paid to utility poles and there is little or no pole attack. But with the developing of more favorable conditions, such as the maturing of young timber or the appearance of large numbers of dead trees, the population may increase to a point where individuals are pressing in on each other and to the degree that territorial defense assumes a major role. Similarly when birds are crowded into ever smaller areas of favorable habitat because of clearing of the land, flooding attending the construction of reservoirs, and the like, territorial competition grows and with it a likelihood of damage to pole lines.

Contributing greatly to the destructive nature of their work on utility poles is the common woodpecker habit of drilling far more holes than are necessary for functional needs. Testing one spot after another, the bird is likely to have caused severe damage even before it eventually completes a roosting or nesting cavity.

The utility pole is selected in many instances over a dead tree, and apparently for a variety of reasons. First of all, the utility pole is located where the woodpecker can view its surroundings to best advantage. Secondly, the utility pole is apt to be of precisely the right elevation and thickness for the woodpecker's hole. The Pileated Woodpecker, for example, finds a transmission pole of any of the sizes conventionally used to be suitable for its hole requirements. On the other hand, distribution poles are generally too small for the Pileated and thereby tend to be neglected. The Ladder-backed

Woodpecker, to give another example, finds the undersides of crossarms on telephone and electric distribution poles to be at the right elevation for its roosting or nesting hole. Crossarms on transmission poles, probably because they are too high, are almost never damaged by this species. Finally there may, in some instances, be a shortage of suitable natural sites. This might be particularly true in the Great Plains where, in spite of few trees, Flickers and Red-headed Woodpeckers are sometimes numerous. Too much emphasis however, should not be placed upon a supposed scarcity of natural sites. Examples have been given of exceptionally heavy woodpecker damage to poles in areas abounding in suitable natural sites.

The tendency of the Pileated to exert its heaviest attack upon new poles has been noted. Presumably attack would dwindle to almost nothing if birds were permitted to keep the roosting and nesting holes that they have finally excavated after so much destructive effort. The same roosting holes are used year after year, and former nesting holes are apparently sometimes used for roosting. How often new nesting holes are established in utility poles, in absence of pole removal or other dislocation, is not known. It may be said that one approach to solving the problem of woodpecker damage to poles would be to line roosting and nesting holes in a way that would protect the untreated interiors of poles from moisture and decay and that would, at the same time, inhibit the woodpecker from enlarging cavities beyond the safe structural capacity of the pole. The present woodpecker repellent, based upon taste repellency, which is offered commercially by Koppers Company to utility users, might be adapted to such a use. It is now being used widely to coat outside surfaces of poles and apparently with good success. A hole filler with the same active ingredient is also in wide use. But the preservation of existing roosting and nesting holes, which typically make up only five percent of the damaging holes on any line, would greatly alleviate pressure upon both untreated poles and those which may have been treated with repellent or covered with hardware cloth. But up to now, to my knowledge, no thought has been given to the possibility of preserving certain holes intact so that pressure may not build up for renewed attack.

Generally speaking there seem to be two seasons of woodpecker attack. There is a period in late summer and early fall when roosting sites are constructed to replace any that may have been lost through removal of tree sites or changing out of damaged poles. Also, young of the year are obliged to make roosting holes. In the Pileated Woodpecker only one bird occupies a roosting hole. Excavation of nesting sites begins in February, as a rule, and extends well into the spring. Birds that start nesting holes in utility poles are apt to spend more time at this activity than birds that select natural sites. They, first of all, lose time through the numerous false starts they make before selecting a final site. Secondly, the usual sound condition of the wood to be found in the interior of the utility pole is apt to retard excavation once the bird is past the first stages of its work.

It might be supposed that the intensified attack that takes place in fall and spring and which is related to the construction of roosting and nesting holes might be impeded if birds failed to detect clues in the pole that seem to denote hollowness or decay. In short, the bird might be expected to refrain from excavating into a completely sound pole that was free of any misleading resonance characteristics. Whether or not such a pole could be produced, the behavior of the woodpeckers that are destructive to poles leaves little room for assurance. Once a bird has set for itself the goal of hollowing out a cavity at a certain spot it isn't likely that it is going to be too greatly deterred by the absence of the characteristic clues it looks for in dead trees. Of more importance to the bird presumably are the dimensions of the pole, the proper altitude, and the opportunity the location affords for observation. As long as such conditions are met, the bird can be expected to attempt its excavation and typically with numerous false starts.

ACKNOWLEDGEMENTS

Without the cooperation of the personnel of the many electric utility companies that I consulted on matters of woodpecker damage, this presentation would have been impossible. Whether dealing with maintenance crews or management I have never had a request turned down or failed to obtain anything but the most courteous response. It would be impossible to list all the names of persons or even all the companies where I have received help and information. I would be ungracious, however, if I did not mention the names of several persons who rendered outstanding assistance.

I am greatly indebted to Mr. O. A. Boyer, Assistant Purchasing Agent of the Central Power and Light Company, Corpus Christi, Texas. Mr. Ludwell Lea, an engineer of the same company, has provided me with valuable assistance. Mr. C. Chetham-Strode, Transmission Engineer of Houston Lighting and Power Company, provided much useful help for which I am very grateful. I was greatly assisted in my field work near Houston by Mr. Claude Kirby of the same company. My studies in eastern Texas were further aided by Mr. J. B. Coltharp, Operations Manager of Gulf States Utility Company, Beaumont, and Mr. George Cannon, Transmission Engineer.

I am indebted to Mr. Robert F. Townsend, Timber Products Engineer of Southern California Edison Company for the help given me in California. For help in Alabama, I am indebted to Mr. Ray C. Smith, Transmission Superintendent of the Alabama Electric Co-op of Andalusia. And for help in eastern Pennsylvania, I am indebted to Mr. Robert Castleberry, Transmission Engineer of the United Gas Improvement Company of Kingston.

For numerous kindnesses and the benefits of conducting studies on a private research refuge, I am indebted to Dr. Clarance Cottam, Director of the Welder Wildlife Foundation, Sinton, Texas, and to all those on his staff.

I have already mentioned the contribution made by Dr. H. R. Burke of the Agricultural and Mechanical College of Texas in identifying the many specimens I sent to him. Finally I am extremely grateful to Mr. J. M. Irvine of Koppers Company who provided help and counsel throughout my study and who has read this paper and supplied corrections.

CONCLUSIONS

1. Damage is regional in nature: it is largely absent in the Pacific Northwest and is of serious proportions in much of Texas, southern California, many parts of the South-Central and Southern States, and in some parts of the Northeast.
2. Seven species of woodpeckers are responsible for serious pole damage problems in North America.
3. The Pileated Woodpecker, a species that has been increasing greatly in numbers since 1920, is responsible for much of the most serious damage.
4. Shakes, hollow pith centers, and other resonance locations in the pole are detected by woodpeckers and are often sites for excavation. Shakes play a particularly important role in the damage caused by the Pileated Woodpecker.
5. The woodpecker's work becomes more difficult as the hole under excavation deepens; hence birds tend to seek out sites where there are indications of internal hollowness or decay.
6. Woodpeckers are fooled by shakes and other minor internal cavities into making unproductive test holes. Such false starts contribute greatly to the total amount of pole damage.
7. Hum or buzz within the pole is not a cause of attack.
8. Shortage of natural sites for roosting and nesting is seldom a basis for woodpecker attack upon poles.
9. Pole damage is associated with woodpecker populations that have reached a density sufficient to compel vigorous defense of territory.
10. To facilitate the guarding of territorial rights certain species, notably the Pileated, have adapted utility poles as lookouts.
11. The clearing of the pole line right-of-way is a disturbing factor that aggravates territorial bickering.
12. With adjustment of territorial boundaries and completion of roosting and nesting holes, pole attack subsides.
13. Because of a strong attachment for any location that has significance as a roosting or nesting site, birds come back to the same poles each year, and, if the pole is replaced by a new one, the new pole is almost certain to be subject to attack and often at exactly the same places.
14. If the old pole is removed and planted at a site near the new one, it will, in all probability, no longer be claimed. Attachment is to a precise location, not to the cavity itself.
15. The altitudinal limits within which a woodpecker tends to confine its work on a pole correspond closely with the altitudinal limits of roosting and nesting holes in trees.
16. The woodpecker tends to pick a site on a pole that is of the right thickness and other dimensions for its roosting or nesting hole.

17. Pole attack corresponds in season to the times of the year when roosting and nesting cavities are made. The Pileated begins its roosting cavity in late summer or early fall and its nesting hole in February or somewhat later.
18. Lining roosting and nesting holes before they are too large, but large enough to accommodate the woodpecker, with a waterproof, decay-inhibiting material that is repellent to woodpeckers, is suggested as an additional technique to use in reducing woodpecker damage to utility lines. Products presently in use could probably be adapted to this purpose.
19. Wood-boring insects are all but absent in well treated utility poles and hence are not a cause of pole attack.
20. Paper wasps in hibernation stage in crevices in poles are sought by the Pileated Woodpecker and perhaps other species.
21. Decayed wood near the groundline supports the largest potential source of food for woodpeckers, yet this is a part of the pole that is virtually free of attack.
22. Food is generally an unimportant factor in woodpecker damage. But much food may be obtained from poles through surface gleaning and probing into holes and checks.

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Received January, 1964

WEIGHTS OF AUTUMN MIGRANTS FROM COASTAL NEW JERSEY

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Weights of birds are being analyzed with increasing frequency in migration studies. Such analyses, made in different areas in different conditions, can lead to a better understanding of migration. In this paper we report and discuss the weights of migrants captured in autumn at the Island Beach Operation Recovery Station in 1959, 1960, and 1961.

METHODS

The Operation Recovery Station is located at Island Beach State Park, Ocean County, New Jersey, on the southern end of a barrier beach peninsula that parallels the mainland. On the east is the Atlantic Ocean, and on the west is Barnegat Bay.

Birds were captured in mist-nets and taken to a central station where they were banded and weighed. The time elapsing between

[1]Scientific names of species mentioned are in Appendix 1.