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ARE PILEATED WOODPECKERS ATTRACTED TO RED-COCKADED WOODPECKER CAVITY TREES?

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ABSTRACT.—Pileated Woodpeckers (*Dryocopus pileatus*) cause damage to Red-cockaded Woodpecker (*Picoides borealis*) cavity trees in the form of cavity enlargement or other excavations on the surface of the pine tree. However, it is not known whether Pileated Woodpeckers excavate more frequently on Red-cockaded Woodpecker cavity trees than on noncavity trees or how stand structure is related to the frequency of Pileated Woodpecker excavation. Also, it is unclear whether the cavity itself provides the stimulus to Pileated Woodpeckers to excavate or whether the presence of Red-cockaded Woodpeckers and their activities are attracting them. We surveyed all of the Red-cockaded Woodpecker cavity trees (n = 202) and 110 control trees in the loblolly (*Pinus taeda*)-shortleaf (*P. echinata*) pine habitat on the Angelina National Forest for recent Pileated Woodpecker excavation and found that approximately 7.4% of all cavity trees were damaged while no control trees showed any evidence of Pileated Woodpecker damage. The rate of Pileated Woodpecker excavation was negatively associated with hardwood midstory height and density. Pileated Woodpeckers appeared to focus most of their excavations on Red-cockaded Woodpeckers cavity entrances. We suggest that Pileated Woodpeckers may be attracted to Red-cockaded Woodpecker cavity trees, especially the cavity, and that midstory removal used to improve Red-cockaded Woodpecker habitat may increase the incidence of damage to the cavity trees by Pileated Woodpeckers in the current fragmented landscape. *Received 24 January 2002, accepted 12 August 2002.*

The endangered Red-cockaded Woodpecker (*Picoides borealis*) evolved in the fire-maintained upland pine savannahs of the southeastern United States (Jackson 1971, Conner et al. 2001). This species may have gained an evolutionary advantage by excavating its roost and nest cavities almost exclusively in living pine trees (Ligon 1970), thereby becoming the most common woodpecker species in an environment where snags likely were short lived due to frequent fires.

Excavating a roost or nest cavity in a living pine tree is a slow process for Red-cockaded Woodpeckers, often taking 2-6 years of intermittent excavation to complete (Conner and Rudolph 1995). A group of Red-cockaded Woodpeckers, usually composed of a breeding pair and one to three helpers (Ligon 1970, Lennartz et al. 1987), excavate roost and nest cavities and defend them from conspecifics. The aggregation of cavity trees excavated by a group of birds is termed the cavity tree cluster. Red-cockaded Woodpeckers excavate shallow holes, termed resin wells, through the bark to the cambium on active trees (cavity trees currently used for roosting or nesting). Resin well excavation likely evolved as a method to keep the cavity entrance open in the living tree (Conner et al. 2001). Left undisturbed, the cambium layer grows over the cavity sealing the entrance (DS and RNC pers. obs.). As a consequence of the frequent resin well pecking, copious amounts of resin flow down the bole of active cavity trees and serve as a barrier to rat snakes (*Elaphe* spp.; Jackson 1974, Rudolph et al. 1990) and occasionally other wildlife species (Schaefer and Saenz 1998). In addition to active cavity trees within the cluster, there often are other inactive cavity trees used previously by woodpecker group members. Cavity tree clusters also can be categorized as active or inactive, with active clusters having at least one active cavity tree. Inactive clusters are sites that have been abandoned by the woodpeckers.

Pileated Woodpeckers (*Dryocopus pileatus*) enlarge Red-cockaded Woodpecker cavities, thereby making them unsuitable for Red-cockaded Woodpeckers, and damage cavity trees (Conner and Rudolph 1995, Saenz et al. 1998). However, Pileated Woodpeckers rarely use enlarged cavities as roost or nest sites (Conner et al. 1997a). It is not clear why Pileated Woodpeckers damage Red-cockaded Woodpecker cavity trees, or if they select them over noncavity trees in the forest. However, Pileated Woodpeckers can destroy cavi-

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ties faster than Red-cockaded Woodpeckers can excavate them (Conner and Rudolph 1995), which could contribute to the decline of this endangered species. Techniques such as artificial cavities (Copeyon 1990, Allen 1991) and restrictors (Carter et al. 1989) have been developed to provide new cavities and protect existing ones.

Our primary objective was to determine if Pileated Woodpeckers are attracted to Red-cockaded Woodpeckers cavity trees. Secondarily, we wanted to identify any characteristics of cavity trees or the cavity tree cluster, such as midstory condition or the presence or absence of Red-cockaded Woodpeckers, that might make cavity trees more or less attractive to Pileated Woodpecker for excavation. Finally, we discuss the potential effects of landscape level events, such as fire suppression and forest fragmentation, which could have increased the co-occurrence and interactions of these two woodpecker species.

STUDY AREA AND METHODS

We studied the interaction between Pileated and Red-cockaded woodpeckers on the Angelina National Forest (31” 15’ N, 94” 15’ W) in eastern Texas. This forest is characterized by having two distinct pine habitat types. The northern portion of the forest is dominated by loblolly (*Pinus taeda*) and shottieaf (*P. echinata*) pine in the overstory, whereas the southern portion of the forest is composed predominantly of longleaf pine (*P. palustris*) in the overstory where Red-cockaded Woodpeckers occur. Most of the cavity tree clusters in both portions of the forest contained naturally excavated cavities and artificial cavities. Almost ail of the artificial cavities in the Angelina National Forest are the “insert” type developed hy Allen (1991). In general, all the cavity tree clusters were managed to provide adequate Red-cockaded Woodpecker habitat, although active cavity tree clusters received priority management, particularly hardwood midstory reduction and suppression, over inactive clusters.

We examined Piieated Woodpecker damage to Red-cockaded Woodpecker cavity trees between 15 March 2000 and 15 April 2000. We examined all Red-cockaded Woodpecker cavity trees for signs of recent (within 2-3 months) cavity enlargement or Pileated Woodpecker damage on the boles of the trees. We distinguished recent excavations from old by their bright yellowish appearance. By using only recent excavations for our comparisons we were able to control foi the length of time a cavity has been in existence. For example, a cavity that has been in existence for several years may have a higher probability of having some Pileated Woodpecker damage during its existence than a newer cavity.

To address our primary objective we compared the incidence of recent Pileated Woodpecker excavation (in the form of either cavity enlargement or rectangulai excavations on the bole of the tree) on Red-cockaded Woodpecker trees (n = 202) to that on control trees (n = 110) selected within the cavity tree clusters. Control trees used in this study did not have any cavities and were chosen at random from among those trees in the cluster that were similar in size and age to cavity trees. This aspect of the study was conducted only in the loblolly-shortleaf pine habitat on the northern portion of the Angelina National Forest, and we used chi-square analysis for the comparison.

We noted the aspect of recent Pileated Woodpecker excavation on all cavity trees (n = 785) relative to the orientation of the Red-cockaded Woodpecker cavity. We divided the tree into two longitudinal halves and compared the amount of Piieated Woodpecker excavation on the side containing the cavity to the opposite side of the tree.

We used a chi-square analysis to compare the incidence of recent Pileated Woodpecker excavation on cavity trees in active clusters (n = 123) to cavity trees in inactive clusters (n = 79) in lohloiiy and shortleaf pine cavity trees, as well as in longieaf pine cavity trees (303 trees in active clusters and 280 trees in inactive clusters). The pine types were compared separateiy to determine if cover type was related to Piieated Woodpecker excavation rates on Red-cockaded Woodpecker cavity trees.

We also used chi-square analyses to compare the incidence of recent Piieated Woodpecker excavation on active (n = 29) and inactive (n = 94) trees within active clusters in iobiolly-shortleaf pine habitat. The same comparisons were made for active (n = 117) and inactive (n = 186) trees within active clusters in longleaf pine habitat. These comparisons were limited to active clusters to reduce any potential cluster site bias from inactive clusters.

We compared the incidence of recent Pileated Woodpecker excavation on trees with naturally excavated cavities (n = 324) to trees with artificial insert cavities (n = 461) using chi-square analysis. For this comparison, we included all cavity trees from active and inactive clusters in both forest types.

We estimated midstory height within the cluster sites to the nearest meter and ranked midstory density from I (little or no midstory present within the cluster area) to 5 (extremely dense midstory within the stand). We compared midstory density using a Mann-Whitney U-rest and height using a t-test between active and inactive cluster sites in loblolly-shortleaf and longieaf pine habitat types. Ail statistical tests were conducted at the $\alpha < 0.05$ level and in ail cases where we failed to reject the null hypothesis we used a power analyses (effect size = 0.30) to determine if we had an adequate sample (Cohen 1988).

RESULTS

Fifteen (7.4%) of 202 cavity trees in loblolly-shortleaf pine habitat were damaged by Pileated Woodpeckers during the 2- to 3-month period prior to sampling while none of the 1 10 control trees had been damaged by Pileated Woodpeckers during that time (χ^2 = 8.58, df = 1, P = 0.003). Recent excavations by Pileated Woodpeckers occurred on only the Red-cockaded Woodpecker cavity side on 35 of 41 trees and on both sides of 6 trees, but on no trees was the excavation exclusively on the opposite side of the cavity.

We found no significant difference (test power = 0.99) between the rate of Pileated Woodpecker excavation in active clusters (6 of 123 cavity trees damaged) and that of inactive clusters (9 of 79 cavity trees damaged) in loblolly-shortleaf pine habitat (χ^2 = 2.97, df = 1, P = 0.085). However, we did observe a higher rate of recent excavation in active clusters (19 of 303 cavity trees damaged) compared to the inactive clusters (7 of 278 cavity trees damaged) in longleaf pine habitat (χ^2 = 4.78, df = 1, P = 0.029).

We found no significant difference (test power = 0.9 1) in the incidence of recent Pileated Woodpecker excavation between active (1 of 29 cavity trees damaged) and inactive trees (5 of 93 cavity trees damaged) within active clusters in loblolly-shortleaf pine habitat (χ^2 = 0.17, df = 1, P = 0.67). We also were unable to detect a difference (test power = 1.00) in the incidence of Pileated Woodpecker excavation in the active (5 of 1 17 cavity trees damaged) and inactive cavity trees (14 of 186 cavity trees damaged) in longleaf pine habitat (χ^2 = 1.29, df = 1, P = 0.26). We detected no significant difference (test power = 1 .OO) in the incidence of recent Pileated Woodpecker excavation between trees with a naturally excavated cavity (I 9 of 324 trees) and an artificial cavity insert (22 of 462 trees, χ^2 = 0.46, df = 1, P = 0.50).

Finally, in loblolly-shortleaf pine habitat we found no significant difference in midstory height between active (mean = 6.1, SE = 0.22) and inactive cluster sites (mean = 8.6, SE = 0.63; t = 0.19, P = 0.19, test power = 0.34), and we found no signihcant difference in midstory density between active (mean = 2.4, SE = 0.70) and inactive cluster sites (mean = 2.2, SE = 0.32; Mann-Whitney U = 39.5, P = 0.65, test power = 0.45). In longleaf pine habitat, midstory height also did not differ significantly between active (mean = 6.6, SE = 0.94) and inactive cluster sites (mean = 8.7, SE = 1.00; t = -1.44, P = 0.16, test power = 0.52). However, in longleaf pine habitat, midstory was significantly denser in the inactive cluster sites (mean = 3.3, SE = 0.25) than in the active sites (mean = 2.0, SE = 0.17; Mann-Whitney U = 136.0, P = 0.001) due to less intensive management.

DISCUSSION

The apparent attraction of Pileated Woodpeckers to Red-cockaded Woodpecker cavity trees remains unexplained. Observations of Pileated Woodpeckers nesting simultaneously in the same tree with other woodpecker species suggest that their excavation behavior is not directed at the reduction of competition with other species (Hoyt 1948, Schemnitz 1964). Red-cockaded Woodpeckers seem defenseless against Pileated Woodpecker destruction of their cavities. The resin barrier, that is effective in deterring rat snakes from Red-cockaded Woodpecker cavities (Jackson 1974, Rudolph et al. 1990), apparently does not deter Pileated Woodpeckers. Pileated Woodpeckers can fly directly to any portion of the cavity tree without having to cross any resin barrier, and then proceed to damage the cavity entrance and tree.

The presence of dense, hardwood midstory vegetation in the cavity tree cluster may reduce the incidence of Pileated Woodpecker damage on cavity trees by making them harder to find. However, Red-cockaded Woodpeckers tend to avoid areas with a dense hardwood midstory and abandon sites when dense midstory vegetation encroaches (Beckett 1971, Grimes 1977, Conner and Rudolph 1989, Loeb et al. 1992). Thus, Red-cockaded Woodpeckers appear to select the type of habitat that makes them most susceptible to losing cavities to enlargement by Pileated Woodpeckers.

While only 7.4% of the cavity trees we surveyed had signs of recent Pileated Woodpecker damage, this rate could result in a large proportion of cavity trees damaged over time. Saenz et al. (1998) found that more than half of the Red-cockaded Woodpecker cavities in longleaf habitat that did not have restrictor plates (a metal plate that inhibits cavity enlargement) were rendered unusable by Pileated Woodpeckers. It seems improbable that Red-cockaded Woodpeckers could have evolved in an environment with that rate of cavity enlargement (Conner and Rudolph 1995). We suggest that either the nature or the frequency of the interaction between these two species has changed relatively recently.

We suggest that habitat alteration may have increased the co-occurrence of these two species to a level that is unsustainable for the Red-cockaded Woodpecker. in particular, pine savannahs have been altered greatly by fire exclusion and suppression, which permitted hardwood midstory encroachment in pine-dominated landscapes (Conner and Rudolph 1991, Conner et al. 2001). These anthropogenic changes may have made previously pine-dominated forests more suitable for Pileated Woodpeckers.

Fire-maintained southern pine ecosystems likely had lower densities of snags than that currently available (Conner and Rudolph 1995, Conner et al. 2001). Fires suppression likely has increased the number of snags that Pileated Woodpecker use for nesting and foraging (Conner et al. 1975, Bull and Jackson 1995). Further, the type of' fires prescribed during the past several decades (i.e., when humidity is high during cooler months; Brender and Cooper 1968) often are insufficiently intense to ignite snags. These cold, wet conditions different from the hot, dry conditions that likely occurred during naturally occurring wildfires during pre-Columbian times.

The conversion of native longleaf pine savannahs to loblolly and slash (P. *elliottii*) pine plantations dctrittg the past 60 years (McWilliatns and Lord 1988) has affected snag density in three ways. First. in contrast to naturally low density longleaf pine, loblolly and slash pine plantations at-e densely stocked, such that there arc mot-e trees (potential snags) per given area. Second, the life expectancy of loblolly pine trees is less than half that of longleaf pines; thus the higher death rate of loblolly pines produces more snags per unit time. Finally, loblolly pines are much more vulnerable to southern pine beetle (*Dendroctonus frontalis*) infestation (Hodges et al. 1979; Conner et al. 1997b, 2001), which kills the pines, producing snags that arc ideal for Pileated Woodpecker cavity excavation and foraging.

Widespread logging of longleaf pines occurred across the South and into Texas during the late 1800s and early 1900s (U.S. Fish and Wildlife Service 1985, Maxwell and Baker 1983, McWilliams and Lord 1988). Cutover lands either regenerated with loblolly and shortleaf pines by natural seeding or were replanted, usually with loblolly pine. The trees of' these relatively unburned, short-lived, second growth loblolly forests now arc of sufficicnt diameter for cavity excavation by Pileated Woodpeckers. Thus, the very high rate of damage to Red-cockaded Woodpecker cavity trees by Pileated Woodpeckers tnay have occurred during only the last several decades, reflecting the proximity of large loblolly pine snags to Red-cockaded Woodpecker cavity tree clusters.

The usc of growing season prescribed burning and restoration of open longleaf pine savannahs likely would reduce the density of snags within Red-cockaded Woodpecker habitat, and thus the density of Pileated Woodpeckers. However, land ownership patterns are problematic in the modern forest landscape. Currently, Red-cockaded Woodpeckers are most prevalent on public land (James 1995) where they have some protection from short rotation titnbcr harvesting. However, these lands typically arc not large contiguous blocks. but instead arc a mosaic of private and public ownership. Pileated Woodpeckers have large home ranges (Kilhatn 1976, Mellen 1987) and regularly travel from unmanaged private lands to managed Red-cockaded Woodpecker cluster sites where they destroy cavities. In the current landscape, Red-cockaded Woodpeckers appear to be extremely vulnerable to cavity destruction (Conner and Rudolph 1995, Saenz et al. 1998) and this situation will not improve unless nearby landowners become committed to restoration of open park-like southern pine ecosystems. Other-wise, tools such as artificial cavities to replace lost cavities and restrictor plates to protect existing cavities likely will be required in perpetuity in many populations if the Red-cockaded Woodpecker is to persist.

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LITERATURE CITED

ALLEN, D. H. 1991. An insert technique for constructing artificial cavities for Red-cockaded Woodpeckers. U.S. Forest Service General Technical Report SE-73, Asheville, North Carolina.

BECKETT, T. 1971. A summary of Red-cockaded Woodpecker observations in South Carolina. Pp. 87–95 *in* The ecology and management of the Red-cockaded Woodpecker (R. L. Thompson, Ed.). Bureau of Sport Fisheries and Wildlife, U.S. Dept. of the Interior and Tall Timbers Research Station, Tallahassee, Florida.

BRENDER, E. V. AND R. W. COOPER. 1968. Prescribed burning in Georgia's Piedmont loblolly pine stands. J. For. 66:31–36.

BULL, E. L. AND J. A. JACKSON. 1995. Pileated Woodpecker (*Dryocopus pileatus*). No. 148 *in* The birds of North America (A. Poole and F. Gill, Eds.). The Academy of Natural Sciences, Philadelphia, Pennsylvania, and the American Ornithologists' Union, Washington, D.C.

CARTER, J. A., J. R. WALTERS, S. H. EVERHART, AND P. D. DOERR. 1989. Restrictors for Red-cockaded Woodpecker cavities. Wildl. Soc. Bull. 17:69–72.

COHEN, J. 1988. Statistical power analyses for the behavioral sciences. Lawrence Erlbaum Associates, Hillsdale, New Jersey.

CONNER, R. N., R. G. HOOPER, H. S. CRAWFORD, AND H. S. MOSBY. 1975. Woodpecker nesting habitat in cut and uncut woodlands in Virginia. J. Wildl. Manage. 39:144–150.

CONNER, R. N. AND D. C. RUDOLPH. 1989. Red-cockaded Woodpecker colony status and trends on the Angelina, Davy Crockett, and Sabine national forests. Research Paper SO-250, U.S. Forest Service, New Orleans, Louisiana.

CONNER, R. N. AND D. C. RUDOLPH. 1991. Forest habitat loss, fragmentation, and Red-cockaded Woodpecker populations. Wilson Bull. 103:446–457.

CONNER, R. N. AND D. C. RUDOLPH. 1995. Excavation dynamics and use patterns of Red-cockaded Woodpecker cavities: relationships with cooperative breeding. Pp. 343–352 *in* Red-cockaded Woodpecker: recovery ecology and management (D. L. Kulhavy, R. G. Hooper, and R. Costa, Eds.). College of Forestry, Stephen F. Austin State Univ., Nacogdoches, Texas.

CONNER, R. N., D. C. RUDOLPH, D. SAENZ, AND R. N. COULSON. 1997b. The Red-cockaded Woodpecker's role in the southern pine ecosystem: population trends and relationships with southern pine beetles. Tex. J. Sci. 49:139–154.

CONNER, R. N., D. C. RUDOLPH, D. SAENZ, AND R. R. SCHAEFER. 1997a. Species using Red-cockaded Woodpecker cavities in eastern Texas. Bull. Tex. Ornithol. Soc. 30:11–16.

CONNER, R. N., D. C. RUDOLPH, AND J. R. WALTERS. 2001. The Red-cockaded Woodpecker: surviving in a fire-maintained ecosystem. Univ. of Texas Press, Austin.

COPEYON, K. C. 1990. A technique for construction of cavities for the Red-cockaded Woodpecker. Wildl. Soc. Bull. 18:303–311.

GRIMES, T. L. 1977. Relationship of Red-cockaded Woodpecker (*Picoides borealis*) productivity to colony area characteristics. M.Sc. thesis, Clemson Univ., Clemson, South Carolina.

HODGES, J. D., W. W. ELAM, W. F. WATSON, AND T. E. NEBEKER. 1979. Oleoresin characteristics and susceptibility of four southern pines to southern pine beetle (Coleoptera: Scolytidae) attacks. Can. Entomol. 111:889–896.

HOYT, J. S. Y. 1948. Observations on nesting associates. Auk 65:188–196.

JACKSON, J. A. 1971. The evolution, taxonomy, distribution, past populations and the current status of the Red-cockaded Woodpecker. Pp. 4–26 *in* The ecology and management of the Red-cockaded Woodpecker (R. L. Thompson, Ed.). Bureau of Sport Fisheries and Wildlife, U.S. Dept. of the Interior and Tall Timbers Research Station, Tallahassee, Florida.

JACKSON, J. A. 1974. Gray rat snakes versus the Red-cockaded Woodpeckers: predator-prey adaptations. Auk 91:342–347.

JAMES, F. C. 1995. The status of the Red-cockaded Woodpecker in 1990 and the prospect for recovery. Pp. 439–451 *in* Red-cockaded Woodpecker: recovery, ecology and management (D. L. Kulhavy, R. G. Hooper, and R. Costa, Eds.). College of Forestry, Stephen F. Austin State Univ., Nacogdoches, Texas.

KILHAM, L. 1976. Winter foraging and associated behavior of Pileated Woodpeckers in Georgia and Florida. Auk 93:15–24.

LIGON, J. D. 1970. Behavior and breeding biology of the Red-cockaded Woodpecker. Auk 87:255–278.

LENNARTZ, M. R., R. G. HOOPER, AND R. F. HARLOW. 1987. Sociality and cooperative breeding of Red-cockaded Woodpeckers (*Picoides borealis*). Behav. Ecol. Sociobiol. 20:77–88.

LOEB, S. C., W. D. PEPPER, AND A. T. DOYLE. 1992. Habitat characteristics of active and abandoned Red-cockaded Woodpecker colonies. South. J. Appl. For. 16:120–125.

MAXWELL, R. S. AND R. D. BAKER. 1983. Sawdust empire: the Texas lumber industry, 1830–1940. Texas A&M Univ. Press, College Station.

MCWILLIAMS, W. H. AND R. G. LORD. 1988. Forest resources of East Texas. USDA Forest Service Resource Bulletin SO-136, New Orleans, Lousiana.

MELLEN, T. K. 1987. Home range and habitat use of Pileated Woodpeckers, western Oregon. M.Sc. thesis, Oregon State Univ., Corvallis.

RUDOLPH, D. C., H. KYLE, AND R. N. CONNER. 1990. Red-cockaded Woodpeckers vs rat snakes: the effectiveness of the resin barrier. Wilson Bull. 102: 14–22.

SAENZ, D., R. N. CONNER, C. E. SHACKELFORD, AND D. C. RUDOLPH. 199X. Pileated Woodpecker damage to Red-cockaded Woodpecker cavity trees in eastern Texas. Wilson Bull. I 10:362–367.

SCHAEFER, R. R. AND D. SAENZ. 1998. Red-cockaded Woodpecker cavity tree resin avoidance by southern flying squirrels. Wilson Bull. I 10:275–276.

SCHEMNITZ, S. D. 1964. Nesting association of Pileated Woodpecker and Yellow-shafted Flicker in a utility pole. Wilson Bull. 76:95.

U.S. FISH AND WILDLIFE SERVICE. 1985. Red-cockaded Woodpecker recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia.