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PILEATED WOODPECKER DAMAGE TO RED-COCKADED WOODPECKER CAVITY TREES IN EASTERN TEXAS

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ABSTRACT-We surveyed all known Red-cockaded Woodpecker (*Picoides borealis*) cavity trees (n = 514) in the Angelina National Forest in eastern Texas for Pileated Woodpecker (*Dryocopus pileatus*) damage. We compared the frequency of Pileated Woodpecker damage to Red-cockaded Woodpecker cavity trees in longleaf pine (*Pinus palustris*) habitat to damage in loblolly (*P. taeda*)-shortleaf (*P. echinata*) pine habitat. We also examined the effectiveness of restrictor plates in deterring Pileated Woodpecker enlargement of Red-cockaded Woodpecker cavities. Pileated Woodpecker damage was significantly greater in longleaf pine habitat than in the loblolly-shortleaf pine habitat in spite of census results showing similar abundance levels of Pileated Woodpeckers in the two forest types. We suggest that limited numbers of snags in the longleaf habitat may focus Pileated Woodpecker excavation on Red-cockaded Woodpecker cavity trees, whereas a greater amount of midstory vegetation in the loblolly-shortleaf pine habitat may serve to reduce visibility, thereby lowering Pileated Woodpecker detection and destruction of Red-cockaded Woodpecker cavities. Restrictor plates were very effective in preventing Pileated Woodpecker enlargement of cavities. While restrictor plates are useful for protecting Red-cockaded Woodpecker cavities, they should be used only in small populations when cavities are in short supply. The Pileated Woodpecker plays an important role, especially in the longleaf ecosystem which is a relatively cavity-barren environment, by providing nesting sites for larger secondary cavity users, such as American Kestrels (*Falco sparverius*), Eastern Screech-Owls (*Otus asio*), and fox squirrels (*Sciurus niger*). *Received 7 Jun. 1998, accepted 20 April 1998*

The federally listed endangered Red-cockaded Woodpecker (*Picoides* borealis; USDI 1970) is endemic to the southeastern United States (Jackson 1971), and is unique because of its dependence on living pine trees in which it excavates roost and nest cavities (Steirly 1957). The pines used as cavity trees are generally mature, because the woodpeckers need heartwood (non-living xylem) large enough in diameter to house a cavity and sufficient time for fungus (*Phellinus pini*) to decay the heartwood for excavation (Jackson and Jackson 1986, Conner and O'Halloran 1987, DeLotelle and Epting 1988, Rudolph and Conner 1991). Young trees usually have thicker sapwood (living xylem that surrounds the heartwood and actively conducts resin) which means a proportionally smaller diameter heartwood (Conner et al. 1994).

The ability to excavate cavities in living pines was likely an evolutionary advantage in the frequently burned pine savannas where snags (standing dead trees that are used for nesting by most primary cavity nesters such as woodpeckers) are short-lived and hardwood midstory is infrequent or absent as a result of frequent fires. It can take several years for Red-cockaded Woodpeckers to fully excavate cavities in living pines but these cavities often last for decades (Conner and Rudolph 1995). Upon cavity completion, the Red-cockaded Woodpecker excavates shallow holes into the xylem, termed resin wells, which are worked regularly to stimulate copious resin flow (Ligon 1970, Dennis 1971). Resin flow may serve to protect cavities from predators and some cavity competitors (Dennis 1968, 1971; Ligon 1970; Jackson 1978; Rudolph et al. 1990). The Red-cockaded Woodpecker can be viewed as a keystone species in the southern pine ecosystem because of its ability to produce cavities in a relatively cavity-barren environment (Conner et al. 1997b). This has a positive impact on faunal diversity by providing cavities for secondary cavity users (Rudolph et al. 1990, Conner 1995, Conner et al. 1997a).

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advantage are now limiting factors because of their scarcity. Current management practices often involve short timber rotations which reduce the number of old trees available for cavity excavation (USDI 1985). Natural fire also has been suppressed allowing hardwood midstory encroachment that causes cluster abandonment (Conner and Rudolph 1989, Loeb et al. 1992). Short rotations and fire suppression are known to be associated with Red-cockaded Woodpecker population declines (Conner and Rudolph 1989, Costa and Escano 1989), and the effects of predators, competitors, and cavity-tree mortality are likely to be magnified in the small, isolated populations that exist today (Jackson 1974, 1978; Conner et al. 1991; Laves 1996).

In Texas, cavity-tree mortality and the effects of cavity damage caused by competitors are a serious concern for managers trying to aid in the recovery of the Red-cockaded Woodpecker. In this paper we examine the damage caused by Pileated Woodpeckers *(Dryocopus pileatus)* to Red-cockaded Woodpecker cavities and evaluate a technique used to prevent the damage. We also evaluate how Pileated Woodpecker damage to cavity trees is influenced by pine forest type, openness of forest, and the availability of snags.

STUDY AREA AND METHODS

Our study site was the Angelina National Forest (62,423 ha; 31” 15’ N, 94” 15’ W) in eastern Texas. The northern portion of the forest is dominated by loblolly (*Pinus taeda*) and shortleaf (P. *echinata*) pines, while the southern portion, is predominately longleaf pine (*P. palustris*). The National Forest is divided in half by the Sam Rayburn Reservoir, isolating the northern and the southern Red-cockaded Woodpecker subpopulations from each other. The two halves of the forest are treated with prescribed burns at irregular intervals. The southern portion is burned at a higher frequency than the northern probably because the longleaf habitat is easier to bum. All cavity-tree clusters on both portions of the National Forest contain both natural and artificial cavities. Natural cavities are excavated completely by the Red-cockaded Woodpecker. Artificial cavities are provided by U.S. Forest Service personnel and come in two types: inserts (Allen 1991) and a modification (Taylor and Hooper 1991) of Copeyon’s (1990) drilled cavity technique.

To evaluate the impact of Pileated Woodpeckers on natural Red-cockaded Woodpecker cavities we exam- cockaded Woodpecker cavities (Carter et al. 1989)] 1984-1996. Trees that contained one or more unrestricted, natural cavities were used in the analysis. Cavities with entrances exceeding 70 mm in diameter are typically not used by Red-cockaded Woodpeckers and were assumed to have been enlarged by Pileated Woodpeckers (Rudolph et al. 1990). No other vertebrate in eastern Texas is likely to enlarge Red-cockaded Woodpecker cavities to this extent (pers. obs.).

All cavity trees (natural and artificial) were checked for evidence of Pileated Woodpecker excavation at Red-cockaded Woodpecker cavities and on other areas of the bole in December 1996. Pileated Woodpecker excavations were identified as coarsely-chiseled rectangular holes pecked through the bark into the xylem of cavity trees. Pileated Woodpecker excavations and cavity enlargement were combined and considered as evidence of Pileated Woodpecker occurrence for the analysis. We tested the null hypothesis that the frequency of Pileated Woodpecker excavation and cavity enlargement in cavity trees in loblolly-shortleaf pine habitat and longleaf pine habitat is equal using χ^2 analyses (P = 0.05) in a 2 X 2 contingency table. By calculating the percentage of trees damaged per year using “cavity tree years,” as a measure of cavity tree availability, we eliminated bias resulting from differences in cavity tree availability between the two habitats.

Fifty-eight of the cavity trees we examined were fitted with 66 restrictor plates by U.S. Forest Service personnel. Some restrictor plates were placed over previously enlarged cavities (n = 4) in an attempt to repair them; such cavities were disregarded in the analysis examining the effectiveness of restrictor plates. Dead trees (6 trees) with restrictor plates (8 cavities) were not used in the analysis because they were potentially more attractive to Pileated Woodpeckers than live pines. We tested the null hypothesis that the rate of cavity enlargement in cavities with restrictor plates (n = 54) and unprotected natural cavities without restrictor plates (n = 276) is equal by use of a χ^2 analysis (P = 0.05) in a 2 X 2 contingency table.

To evaluate relative abundance of Pileated Woodpeckers within the loblolly-shortleaf pine habitat and longleaf pine habitats, we censused the birds using 5-min point counts during winter (1 January to 15 February) and spring (1 May to 15 June) in 1995 and 1996. Twenty sites in each habitat type were censused six times per season. Sampling was conducted one half hour before sunrise to 3 hours post sunrise. Sampling was not conducted during heavy rain or excessive winds (>20 km/h). We used a two-tailed t-test to compare Pileated Woodpecker abundance in the two habitat types.

To obtain a measure of midstory openness and availability of snags we randomly selected and sampled vegetation in 160, 11.2 m radius plots (0.04 ha) in each habitat type [as described by James and Shugart (1970)

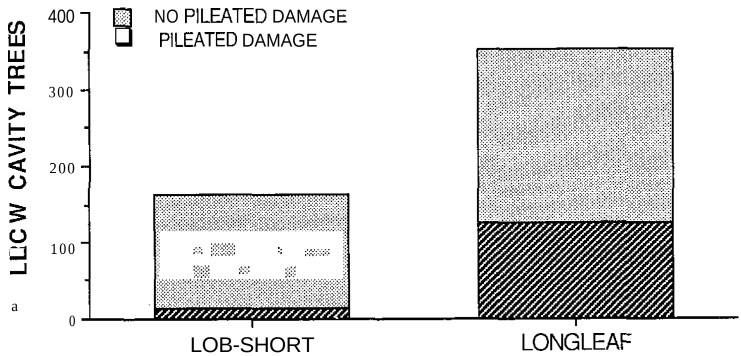


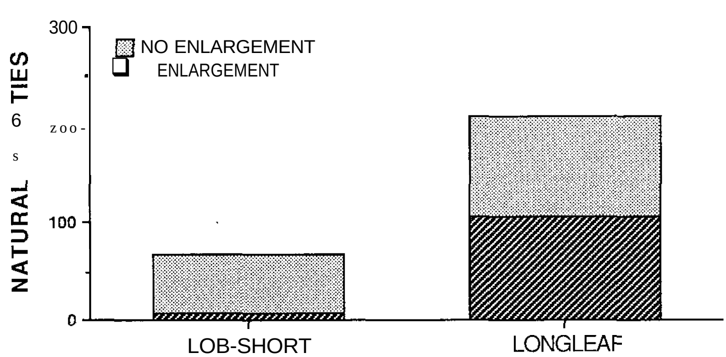
FIG. 1. The number of Red-cockaded Woodpecker cavity trees on the Angelina National Forest damaged by Pileated Woodpeckers (cavity enlargement or other excavations) in loblolly-shortleaf pine habitat compared to longleaf pine habitat ($\chi^2 = 41.2$, $P < 0.001$).

sapling (5-16 cm DBH) and pole (17-32 cm DBH) hardwoods and pines in each plot. Two-tailed t-tests were used to compare snag availability and midstory openness between the loblolly-shortleaf pine and the longleaf pine forest types. All analyses were calculated using PC-SAS (SAS Institute, Inc. 1988).

RESULTS

Pileated Woodpeckers regularly excavated into Red-cockaded Woodpecker cavity trees and enlarged cavity entrances; 27.2% (140 of 5 14 cavity trees, both habitat types combined) showed some evidence of Pileated Woodpecker damage. Pileated Woodpecker damage to Red-cockaded Woodpecker cavity trees was significantly greater in longleaf pine habitat than in loblolly-shortleaf pine habitat ($\chi^2 = 41.2$, $P < 0.001$; Fig 1). In the longleaf pine habitat type 35.8% (126 of 352) of the cavity trees showed signs of Pileated Woodpecker excavation whereas 8.6% (14 of 162) of the cavity trees showed signs of woodpecker excavations in the loblolly-shortleaf pine habitat. About 4.8% of all cavity trees in the longleaf pine habitat were damaged annually by Pileated Woodpeckers compared to 1.3% in the loblolly-shortleaf pine habitat.

Two hundred nineteen natural cavity trees contained 276 cavities without restrictor plates. Cavity enlargement occurred in 41.3% (114 of 276) of all unrestricted cavities. Pileated Woodpeckers enlarged Red-cockaded Woodpecker cavities at a significantly greater rate in longleaf pine habitat than loblolly-shortleaf pine habitat ($\chi^2 = 31.5$, $P < 0.001$; Fig 2). In longleaf pine habitat 50.7% (106 of 209) of the unrestricted cavities were enlarged whereas only 11.9% (8 of 67) were enlarged in loblolly-shortleaf pine habitat. Approximately 2.8% of the cavity trees in the longleaf pine habitat were enlarged by Pileated Wood-



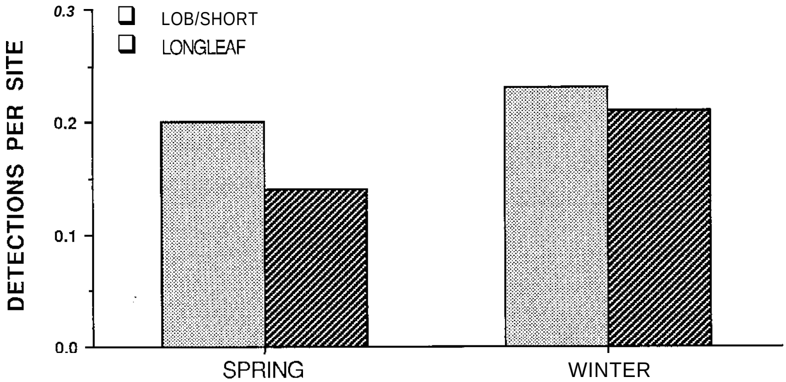


FIG. 3. The mean number of Pileated Woodpeckers detected at each site in loblolly-shortleaf pine habitat compared to longleaf pine habitat during spring (t = 1.31, $P > 0.05$) and winter (t = 0.36, $P > 0.05$) surveys.

peckers annually compared to only 0.8% enlargement in the loblolly-shortleaf pine habitat.

Restrictor plates (n = 54) were very effective in preventing enlargement by Pileated Woodpeckers as compared to unprotected cavities (χ^2 = 31.0, $P < 0.001$). In only one instance were Pileated Woodpeckers able to destroy a cavity fitted with a restrictor plate. The Pileated Woodpecker excavated a second entrance above the restrictor plate exposing the cavity above the original cavity entrance.

Abundance estimates from point counts revealed that Pileated Woodpeckers were similarly abundant in the two pine habitat types (Fig 3). We failed to detect differences between habitat types in Pileated Woodpecker abundance during both winter (t = 0.355, $P > 0.05$) and spring (t = 1.310, $P > 0.05$).

There were significantly more and larger snags in loblolly-shortleaf pine habitat than in longleaf pine habitat ($P < 0.001$; Table 1). The mid-story components (sapling and pole-size pine and hardwood trees) were also significantly more abundant in loblolly-shortleaf pine habitat than longleaf pine habitat ($P < 0.001$; Table 1).

DISCUSSION

Many Red-cockaded Woodpecker cavity trees in the Angelina National Forest were damaged by Pileated Woodpeckers. Because a large population of Pileated Woodpeckers is present across the forest, the difference in the amount of Pileated Woodpecker damage between the longleaf pine habitat and the loblolly-shortleaf pine habitat is surprising.

At least two factors may account for the differences in Pileated Woodpecker damage to Red-cockaded Woodpecker cavity trees between the two habitat types. We suggest that the relatively low number of snags in the longleaf habitat as a result of frequent burning and longer lived longleaf pine trees may focus

TABLE 1. Habitat comparisons between longleaf habitat and loblolly-shortleaf habitat.

Habitat[b] components	Lob-Short[a]		Longleaf[a]			
	$\bar{x}$	(SD)	$\bar{x}$	(SD)	t	P
TOTSNAG	1.95	1.97	0.25	0.55	10.539	<0.001
LRGSNAG	0.5 1	1.07	0.09	0.31	4.753	<0.001
SAPLHWD	9.07	5.60	0.53	0.91	19.045	<0.001
POLEHWD	1.48	1.33	0.09	0.20	13.114	<0.001
SAPLPIN	6.67	10.04	2.21	1.57	5.552	<0.001
POLEPIN	1.94	1.69	0.92	0.74	7.014	<0.001

more of the attention of Pileated Woodpeckers on Red-cockaded Woodpecker cavity trees than in the loblolly-shortleaf pine habitat where snags are more abundant. Pileated Woodpeckers are known to use snags extensively for foraging and excavating roost and nest cavities (Conner et al. 1975, Kilham 1976, Bull and Meslow 1977, Conner 1980, Bull 1987). We also suggest that the openness of the frequently burned longleaf pine habitat may allow Red-cockaded Woodpecker trees to be more easily detected by Pileated Woodpeckers than trees in the infrequently burned loblolly-shortleaf pine habitat.

The reasons why Pileated Woodpeckers excavate holes in Red-cockaded Woodpecker cavity trees and enlarge cavities still are poorly understood. Pileated Woodpeckers only infrequently use such trees for roosts or nests (Conner et al. 1996). We suggest that Pileated Woodpeckers are attracted by excavations of other woodpeckers, in this case Red-cockaded Woodpecker cavities, and begin excavating possibly for either foraging or nesting. We also suggest that the sapwood is likely excavated in the process of enlarging the cavity chamber causing copious amounts of sticky resin to flow at the excavation site or into the cavity, and that this may discourage Pileated Woodpeckers from completely excavating a cavity. Although these enlarged cavities may not be fully excavated by the Pileated Woodpeckers, the amount of enlargement is usually sufficient for other cavity nesters.

Restrictor plates effectively prevented Pileated Woodpecker enlargement of Red-cockaded Woodpecker cavities. However, we caution against using restrictor plates on all Red-cockaded Woodpecker cavities. Although the Red-cockaded Woodpecker plays an important role in longleaf pine ecosystems by providing cavities for smaller secondary cavity nesters, the Pileated Woodpecker may play an equally important role by enlarging Red-cockaded Woodpecker cavities and providing nest sites for larger secondary cavity nesters, such as American Kestrels (*Falco sparverius*), Eastern Screech-Owls (*Otus asio*), and fox squirrels (*Sciurus niger*; Conner et al. 1997a). While we know that restrictor plates are a good man-

Woodpeckers should be allowed to enlarge cavities for larger secondary cavity nesters in areas where Red-cockaded Woodpecker populations are stable, as a way to maintain natural fauna1 diversity.

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