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Initial and long-term use of inserts by red-cockaded woodpeckers

Daniel Saenz, Richard N. Conner, Christopher S. Collins, and D. Craig Rudolph

Abstract Artificial cavities have become a standard management technique for red-cockaded woodpeckers (*Picoides borealis*). Seventy cavity inserts were installed in our study sites on the Angelina National Forest in eastern Texas from 1990 to 1995. Eighty-two percent of the inserts were used for at least one year. It is still too early to make a direct comparison, but it is likely that inserts will remain usable as long as natural cavities do. Inserts installed in 1990 and 1991 were 20.5 cm in height, whereas inserts installed from 1992 to 1995 were 25.5 cm in height. Larger inserts (25.5 cm) appear to remain usable for a longer time than smaller inserts (20.5 cm). Newer unused inserts are more likely to become active for the first time than older unused inserts. Similar to unused inserts, active cavities (naturally excavated and inserts) that have become inactive are less likely to be reactivated the longer they are inactive. Newness and recency of cavity use and red-cockaded woodpecker activity appear to be important factors in the attractiveness of inserts and naturally excavated cavities.

Key words active cavity, artificial cavity, cavity tree, insert cavity, *Picoides borealis,* red-cockaded woodpecker

Red-cockaded woodpeckers excavate their roost and nest cavities in a "cluster" of living pines (*Pinus* spp.) that are generally close to each other. During the 1980s, red-cockaded woodpecker populations were declining in many parts of the species' range (James 1995). Conner and Rudolph (1995*a*) reported that cavity losses were exceeding new cavity excavation by the woodpeckers in eastern Texas and that this might be a factor in causing cluster abandonment and subsequent population declines. Techniques to provide artificial cavities were developed in the late 1980s to offset the presumed cavity deficit. Copeyon (1990) developed one type of artificial red-cockaded woodpecker cavity by drilling a cavity directly into the heartwood of a living pine tree. Allen (1991) followed with an insert design that consisted of a nest box made of western redcedar (*Thuja plicata*) that is inserted into a living pine tree with the aide of a chainsaw. The insert had an advantage over the drilled cavity in that it could be used in trees with smaller heartwood diameters (typical of younger trees) as long as the overall diameter of the tree was large enough to house the insert (>38 cm). The insert was chosen as the only artificial cavity type to be used in Texas because it was easier to install.

Artificial cavities were first installed in the national forests in Texas in1990. By this time red-cockaded woodpecker populations in Texas were declining (Ortego et al. 1988, Conner and Rudolph 1989) and cavities were thought to be a limiting factor (Conner and Rudolph 1995*a*). Since 1990, red-cockaded woodpecker populations in Texas national forests have stabilized and some have shown moderate increases (Conner et al. 1997*b*). A large proportion (67%) of the current population on the Angelina National Forest is now roosting and nesting in artificial cavities.

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Our objective was to determine the frequency of use of inserts by red-cockaded woodpeckers. We also compared the usable life spans of inserts with those of natural cavities. Finally, we determined the usable life span of inserts and how initial use and periods of inactivity of insert and naturally excavated cavities affect the probability of subsequent use.

Study area

We conducted the study on the southern portion of the Angelina National Forest in eastern Texas. We worked in longleaf pine (*Pinus palustris*) stands because longleaf is much more resistant to southern pine beetle (*Dendroctonus frontalis*) infestation than are loblolly (*P. taeda*) and shortleaf (*P. echinata*) pines (Conner et al. 1991, Conner and Rudolph 1995*a*, Conner et al. 1998*a*), resulting in a lower incidence of cavity-tree turnover. This allowed us to focus on cavity selection by red-cockaded woodpeckers without the confounding effects of a high incidence of cavity-tree mortality.

Methods

We surveyed active clusters (those with at least one tree in which a red-cockaded woodpecker was roosting at night) annually on the southern portion of the Angelina National Forest for red-cockaded woodpecker activity from 1983 to 1999. Fresh excavation at resin wells was used to distinguish between active and inactive cavities (Jackson 1978). We conducted surveys immediately prior to the nesting season to obtain a prebreeding season estimate of woodpecker cavity use. We did not determine the internal status of the cavities, and we never cleaned debris from cavities that may influence use rates. However, a program to remove southern flying squirrels (*Glaucomys volans*) was implemented in active clusters on the Angelina National Forest beginning in 1998 (Ronald Mize, personal communication).

Seventy inserts were installed into 12 active clusters over a 6-year period from 1990 to 1995. Inserts installed in 1990 and 1991 were smaller (20.5 cm in height) than inserts installed from 1992 to 1995 (25.5 cm in height). We surveyed the clusters for woodpecker activity to determine insert use rate and the long-term usability of inserts. The same clusters also were surveyed to determine the length of time that naturally excavated cavities were used by red-cockaded woodpeckers between 1983 and 1999. The survey was expanded to include cavities that were excavated prior to the implementation of inserts to obtain a sufficient sample size.

We combined all data on inserts to determine the proportion of use the following year after installation. Inserts that were not used in their first year were combined to determine the proportion of use in the second year following installation. We continued to combine data for remaining inserts to determine the proportion of inserts initially used in a given age class for a total of 9 years. We used a logistic regression analysis to determine whether the probability of a cavity insert being used for the first time was related to insert age. Our sample size was too small within year and variable among years to evaluate the effect of year.

Naturally excavated cavities and inserts that were active at any time during the study and later became inactive (n=78 and 23, respectively) were examined from 1983 to 1999 to determine the proportion that would become active again after a period of inactivity. We combined the unused cavities from each age cohort and determined the proportion of cavities that became active after a given period of inactivity, up to 5 years. We used a logistic regression analysis to determine whether the probability of a cavity becoming active after a period of inactivity was related to the length of time the cavity was inactive. Our sample size also was too small within year and variable among years in this model to evaluate the effect of year.

Results

Red-cockaded woodpeckers used 82% of the cavity inserts installed in the southern portion of the Angelina National Forest for at least 1 year between 1990 and 1999. Inserts also were used by several other species of wildlife (Conner et al. 1996, Conner et al. 1997*a*), possibly precluding use by red-cockaded woodpeckers in some instances. A slightly larger proportion of the older, smaller inserts received use by red-cockaded woodpeckers initially, but most of the use occurred when cavities were in short supply and the inserts were new. Use of these inserts dropped markedly as they aged (Figure 1). A slightly lesser proportion of the newer, larger inserts were used, but amount of use did not decrease at the same rate as that of the older, smaller inserts (Figure 1).

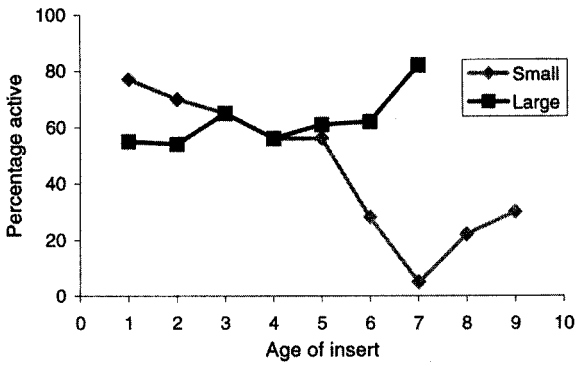


Figure 1. Percentage of small and large inserts used by red-cockaded woodpeckers (active) by insert age. Small inserts (20.5 cm in height) were installed in 1990 and 1991. Large inserts (25.5 cm in height) were installed from 1992 to 1995.

Thirty-two cavities were naturally excavated by red-cockaded woodpeckers in the study site from 1983 to 1999, ranging in age from one to 16 years. Natural cavities were used a minimum of 1 year and a maximum of 12 years. To date, inserts have been used for 0 years to 8 years.

Logistic regression analysis indicated that the probability of an insert being used for the first time declined as the insert aged (Table 1). Sixty percent (42 inserts) of the 70 inserts in the longleaf habitat were used in their first year after installation. Our model predicted a 350% decrease in odds of an insert cavity becoming active for the first time with each additional year of age. No unused inserts over 5 years of age have ever become active in our study site (Figure 2).

Logistic regression analysis indicated that the probability of a cavity becoming active after a period of inactivity declined the longer a cavity was inactive (Table 1). Forty-five percent of cavities (naturally excavated and inserts combined) became active again after one year of inactivity. Our model predicted a 36% decrease in odds of a cavity becoming active with each additional year of inactivity. No originally active cavity that had become inactive for more than 4 years has yet to be used by red-cockaded woodpeckers in this study (Figure 3).

Figure 2. Percentage of cavities receiving initial use by red-cockaded woodpeckers by insert age. All inserts (n = 70) were combined and used cavities were removed from the following year's sample so that the proportion of cavities used for the first time in each age group can be calculated.

Table 1. Probability of cavity use by red-cockaded woodpeckers as a function of insert age and length of time a cavity was inactive on the Angelina National Forest in eastern Texas from 1983 to 1999.

Model Variable	Estimate[a]	SE[b]	R^2 [c]	χ^2 [d]	$P>\chi^2$ [e]	Odds ratio
Insert age						
Intercept	1.39	0.36		14.79	<0.001	
Age	–1.26	0.18	0.33	48.73	<0.001	0.29
Length of inactivity						
Intercept	–0.51	0.09		31.15	<0.001	
Inactivity	1.01	0.08	0.30	132.16	<0.001	2.75

[a] Estimate of explanatory slope (β_x).
[b] Standard error of slope estimate.
[c] Percentage of variation explained by the explanatory variable in the model (Menard 1995).
[d] χ^2 statistic testing H_0: slope estimate = 0.
[e] Probability to reject H_0.

Discussion

A large proportion of inserts installed in the southern portion of Angelina National Forest were used by red-cockaded woodpeckers, regardless of

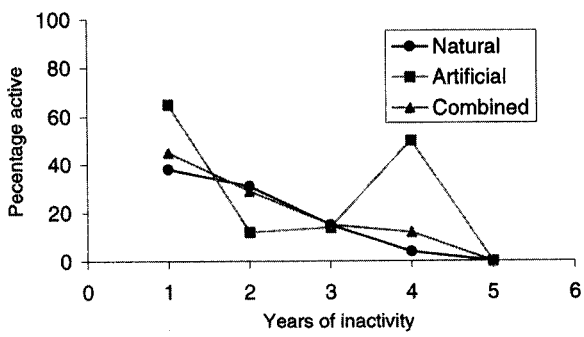
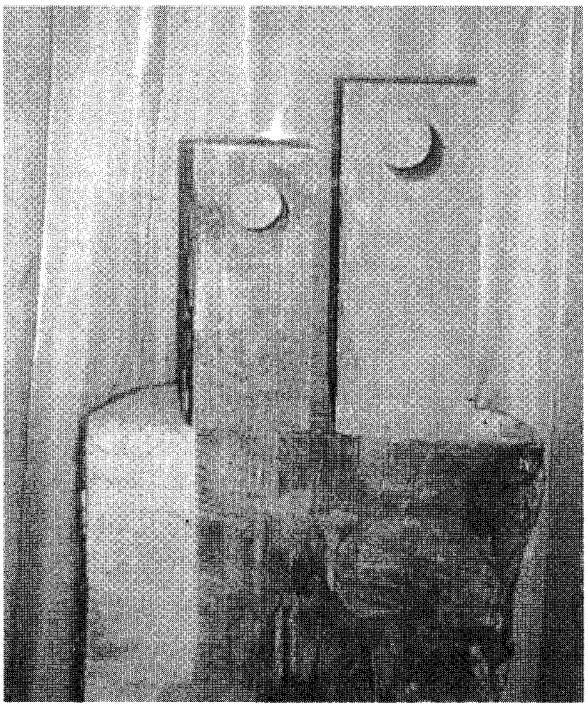


Figure 3. Percentage of reactivation by red-cockaded woodpeckers after a period of inactivity by the number of years of inactivity. Cavities that had become active again after a period of inactivity were removed from the following year's sample so that the proportion of cavities reactivating after a given period of inactivity could be calculated. The peak that occurred in year 4 of inactivity is due to the small sample of artificial cavities in that age group. Natural cavities (n = 78) and inserts (n = 23) are graphed separately and combined.

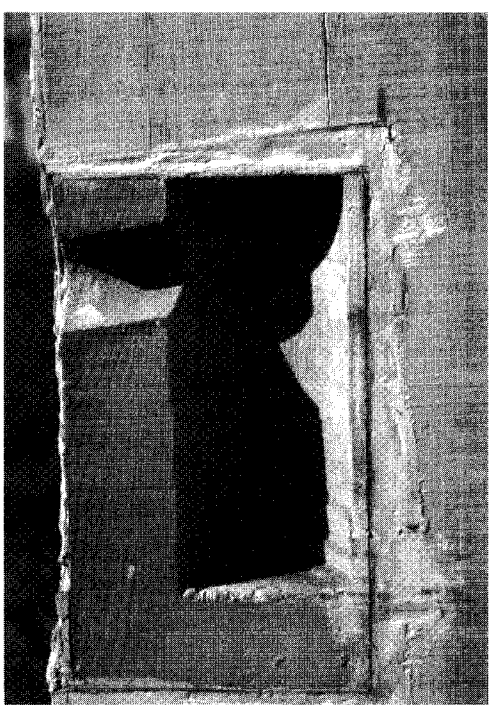


Original-style cavity insert (20.5 cm in height) on left compared to new, larger insert (25.5 cm in height) on right.

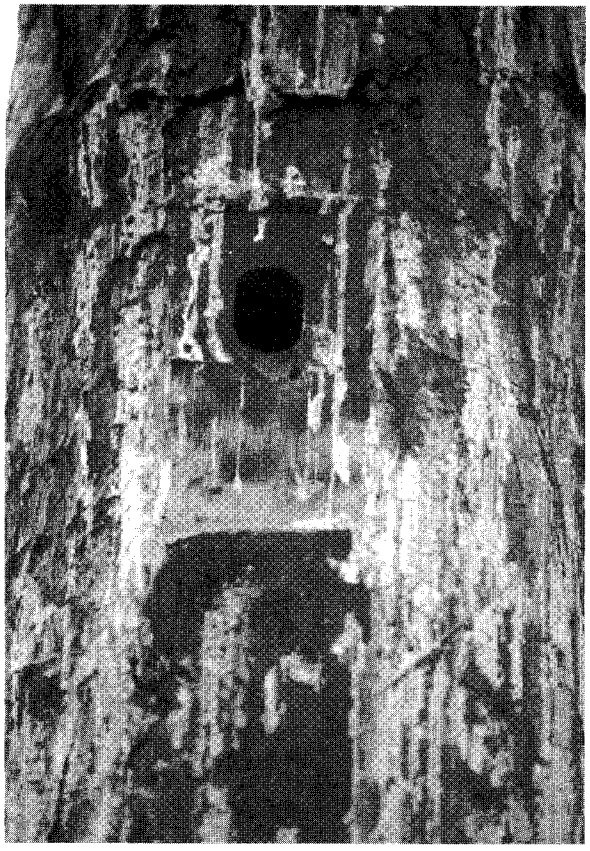
the size of the insert. The smaller inserts that were initially installed received immediate use by the woodpeckers, probably because there was a very high demand at that time for cavities (Conner and Rudolph 1995). After the newer, larger cavities were installed, use of the smaller insert cavities dropped because the birds apparently preferred the larger and newer cavities. The continued high use of the larger inserts (Figure 1) suggests a preference over the smaller ones.

No naturally excavated cavity in our study site has been active more than 12 years, whereas 82% of the 7-year-old inserts were still being used in 1999. Natural cavities are often excavated in pines that are infected with red-heart fungus (*Phellinus pini*, Jackson 1977, Conner and Locke 1982, Hooper 1988, Hooper et al. 1991, Conner et al. 1994), which facilitates cavity excavation. The same fungus that facilitates excavation may reduce the useful life span of a cavity because the bottoms of cavities often rot to a condition that is unacceptable to red-cockaded woodpeckers. Inserts, which are made of western redcedar, are very resistant to decay and may last longer than naturally excavated cavities with heart rot. Thus, it appears that in this population inserts may remain usable for at least as long as natural cavities.

Long-term usability of inserts might be correlated with initial use. The chance of an insert being used drops considerably if the insert is not used within the first couple of years. But if it is used, it appears to remain usable for years. It is unknown why unused inserts lose their attractiveness over time while active inserts remain attractive. One possibility is that some cavity trees chosen by the biologist for insert installation may not be attractive to red-cockaded woodpeckers while others are attractive. For example, trees that produce large amounts of resin are probably preferred by red-cockaded woodpeckers over trees that produce less resin (Conner et al. 1998*b*), so trees that produce small amounts of resin may never be used. Alternatively, woodpeckers may maintain their cavities in a condition that is similar to new inserts, whereas unused inserts may somehow degrade in quality. Unused cavities are often used by southern flying squirrels (Rudolph et al. 1990, Loeb 1993, Conner et al. 1996). Their feces and urine may render cavities less attractive to red-cockaded woodpeckers. If there is a cavity shortage or if a biologist judges that a replacement insert is needed, then it could be placed higher in a tree with an existing insert, an additional tree, or reinserted in the old insert tree where the old insert had been extracted.



Cross-section of a red-cockaded woodpecker cavity insert within a pine tree.



A cavity insert recently installed in a living pine tree, exhibiting newly excavated resin wells indicating current use by a woodpecker.

Conner et al. (1998*b*) demonstrated that breeding male red-cockaded woodpeckers prefer newer cavities. The insides of new inserts appear to be lighter in color than old cavities (Saenz et al., personal observations). The insides of active cavities (including inserts) are often pecked by red-cockaded woodpeckers, giving them a lighter color than that of unused cavities. Perhaps the brightness of the interior portion of cavities is a factor in determining their attractiveness to red-cockaded woodpeckers.

In Texas, the bark of the insert tree is usually scraped smooth with a drawknife to facilitate insert installation. Scraped bark gives the tree the same smooth, reddish appearance that characterizes an active cavity tree (Saenz et al., personal observations). Mock resin wells also are painted on the trees with gray spray paint to attract woodpeckers (Steve Best, personal communication). Over time, if a tree is not used by a red-cockaded woodpecker, it begins to look inactive because the bark roughens and loses its reddish appearance and the mock resin wells fade. The external appearance of an insert tree may be as important to attract red-cockaded woodpeckers as condition of the interior of the inserts.

Active natural cavities and inserts that become inactive show a similar trend in the probability of becoming active again as unused inserts show for initially becoming active. The longer a cavity is inactive, the lower the probability of its ever becoming active again. In our study, natural cavities and cavity inserts follow this trend, which reduces the possibility that poor tree selection by biologists will cause the observed phenomenon. Interestingly, Doerr et al. (1989) noted that recently abandoned red-cockaded woodpecker clusters in North Carolina were reoccupied at a greater rate than long-abandoned clusters.

Copeyon et al. (1991) and Walters et al. (1992) demonstrated that the use of artificial (drilled) cavities, in addition to providing cavities for existing groups, can be an effective way to induce red-cockaded woodpeckers to occupy previously unoccupied habitat and form new social groups. Inserts are used readily by red-cockaded woodpeckers in Texas and also should provide excellent opportunities to induce birds to occupy new habitats and to form new social groups as long as good inserts are available. Based on our findings, it is possible that older inserts may not be as attractive to woodpeckers and that the absence of new inserts may limit the success of new group formation with artificial cavities.

Inserts are proving to be an excellent technique in the red-cockaded woodpecker recovery effort. Research is still needed to determine whether insert maintenance, routine cleaning, and activities such as bark scraping and painting can prolong the initial period of attractiveness to red-cockaded woodpeckers. Additionally, inserts also may play a research role in understanding certain natural history attributes important to red-cockaded woodpecker recovery. Studies of cavity inserts also may be important in developing an understanding of natural cavity excavation rates in woodpecker clusters with high and low cavity densities. Research using inserts also may help to answer questions about cavity-tree selection and cavity quality.

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