

**RED-COCKADED WOODPECKER REPRODUCTION,  
NEST LOSS, AND CAVITY KLEPTOPARASITISM  
IN A MISSISSIPPI LOBLOLLY-SHORTLEAF  
PINE ECOSYSTEM**

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**Abstract.** The recovery of the endangered Red-cockaded Woodpecker (*Picoides borealis*) depends on successful reproduction, limited interspecific competition, and reduced nest predation. From 1997–1999, we examined Red-cockaded Woodpecker reproduction, nest loss, and cavity kleptoparasitism in a loblolly (*Pinus taeda*) and shortleaf (*P. echinata*) pine ecosystem in Mississippi. Red-cockaded Woodpeckers had high annual nesting rates (67–73%). Mean clutch size was 3.1 eggs with an 88% hatching rate. Red-cockaded Woodpeckers had a 71% fledging rate and fledged approximately 2.0 young/nest. We observed partial brood loss of approximately one nestling/nest. Southern flying squirrels (*Glaucomys volans*) and Red-bellied Woodpeckers (*Melanerpes carolinus*) frequently usurped Red-cockaded Woodpecker cavities. We recorded five occurrences of flying squirrels consuming Red-cockaded Woodpecker eggs and three occasions of gray rat snakes (*Elaphe obsoleta spiloides*) consuming nestlings. Although Red-cockaded Woodpecker reproductive success was relatively high, cavity usurpation can present a threat to future reproductive success within local populations.

**Key words:** cavities, gray rat snake, Mississippi, *Picoides borealis*, Red-bellied Woodpecker, Red-cockaded Woodpecker, reproduction, southern flying squirrel

## INTRODUCTION

Red-cockaded Woodpeckers (*Picoides borealis*) are a federally-endangered species endemic to pine ecosystems of the Southeast (Jackson 1994). Red-cockaded Woodpeckers are cooperative breeders with helpers at the nest, usually

male offspring of the breeding pair (Lennartz et al. 1987, Walters et al. 1988). Nesting typically occurs from 7 April–31 July, although most breeding activity concludes by mid-June (Jackson 1994). Red-cockaded Woodpeckers normally nest once annually; however, consecutive broods have been reported (LaBranche et al. 1994). Plural breeding, defined as 2 simultaneous nests by the same Red-cockaded Woodpecker group, also has been reported (Rossell and Britcher 1994). High annual rates of nesting attempted (74–91%) are common (LaBranche and Walters 1994).

Clutch size ranges from 1–4 eggs/nest with a mean of 3 eggs/nest across the species' range (Jackson 1994). Incubation requires 10–12 days and nestlings fledge at 24–26 days (Jackson 1994). Incubation and feeding of nestlings are shared by the breeding pair and helpers (Walters et al. 1988). Partial brood loss typically occurs at the early nestling stage (i.e., hatching to 7 days of age) and mortality is high during the post-fledging stage and dispersal (Walters et al. 1992).

Kleptoparasitism of Red-cockaded Woodpecker cavities is known to occur (Harlow and Lennartz 1983, Conner et al. 1997, Kappes and Harris 1995, Loeb and Hooper 1997). Forest type and geographic variation appear to influence the species usurping Red-cockaded Woodpecker cavities. In a loblolly (*Pinus taeda*) and shortleaf (*P. echinata*) pine forest in Texas, Conner et al. (1996) reported southern flying squirrels to be the most common usurper of Red-cockaded Woodpecker cavities. Similarly, in a South Carolina longleaf pine (*P. palustris*) forest, southern flying squirrels frequently occupied Red-cockaded Woodpecker cavities (Harlow and Lennartz 1983). However, in a longleaf forest in Florida, Kappes and Harris (1995) reported

Red-bellied Woodpeckers (*Melanerpes carolinus*) as the predominant usurper of Red-cockaded Woodpecker cavities.

Red-cockaded Woodpeckers are cooperative breeders, which results in increased vigilance for aerial predators and therefore a low probability of adult mortality (Wood 1983). However, Red-cockaded Woodpecker eggs and nestlings are vulnerable to a diverse suite of predators. LaBranche and Walters (1994) reported predation of Red-cockaded Woodpecker eggs by Red-bellied Woodpeckers and Red-headed Woodpeckers (*Melanerpes erythrocephalus*). Gray rat snakes (*Elaphe obsoleta spiloides*) (Jackson 1976, 1978, Summerour 1988), corn snakes (*Elaphe guttata guttata*) (Phillips and Gault 1997), black rat snakes (*E. obsoleta obsoleta*) (Neal et al. 1993), and southern flying squirrels (*Glaucomys volans*) (LaBranche and Walters 1994) are all documented predators of Red-cockaded Woodpecker nestlings and eggs.

## METHODS

The Bienville National Forest, located in central Mississippi, is a predominantly loblolly and shortleaf pine ecosystem (Wood 2001). With a range of 104–106 active groups (including single male groups), Bienville National Forest contains a medium-sized subpopulation of Red-cockaded Woodpeckers. The total number of active Red-cockaded Woodpecker groups varied by year (1997 = 104, 1998 = 106, 1999 = 106). We recorded reproductive success parameters for all active Red-cockaded Woodpecker groups annually. Reproductive success variables measured included percent of groups attempting nesting ( $\geq 1$  egg laid), clutch size, number of eggs hatched, nestlings surviving until

10 days post-hatching, and number fledged. We used the Treetop Peeper Scope™ (Christensen Designs, Manteca, California), a camera system mounted on a telescoping pole, at 3 day intervals to examine cavity contents. Nests were checked daily as nestlings approached fledging to record fledging date. We also made anecdotal observations of cavity kleptoparasitism, nest loss, and predation of Red-cockaded Woodpeckers. We banded Red-cockaded Woodpecker nestlings 7–10 days post-hatching (Wood et al. 2001). Nestlings were removed from the cavity using a noose technique developed by Jackson (1982). Nestlings were returned promptly to the cavity and no nestlings were injured during the study.

## RESULTS

### Reproductive success

In 1997, a high percentage of Red-cockaded Woodpecker groups attempted nesting ( $70/104 = 67\%$ ) at Bienville National Forest. Sixty-seven percent of all groups attempted nesting with a mean clutch size of 3.1 eggs ( $SE = 0.12$ ). A mean of 2.7 eggs ( $SE = 0.12$ ) hatched with a mean of 2.5 nestlings ( $SE = 0.13$ ) surviving until 10 days post-hatching. However, only 2.0 young/nest ( $SE = 0.17$ ) fledged, demonstrating a partial brood loss of approximately one nestling/nest.

In 1998, 71% ( $75/106$ ) of Red-cockaded Woodpecker groups attempted nesting. Mean clutch size was 3.1 eggs ( $SE = 0.12$ ). A mean of 2.8 eggs ( $SE = 0.14$ ) hatched with an average of 2.5 nestlings ( $SE = 0.12$ ) surviving until 10 days post-hatching. Similar to 1997, 2.0 young/nest ( $SE =$

0.22) fledged, with a partial brood loss of approximately 1 nestling/nest.

In 1999, 77/106 (73%) Red-cockaded Woodpecker groups attempted nesting with a mean clutch size of 3.3 eggs (SE = 0.17). A mean of 2.9 eggs (SE = 0.13) hatched with a mean of 2.6 nestlings (SE = 0.14) surviving until 10 days post-hatching. Red-cockaded Woodpeckers fledged a mean of 2.1 young/nest (SE = 0.20), demonstrating a loss of approximately one nestling during the nestling stage.

### **Mortality and cavity kleptoparasitism**

We documented nest failures due to avian, reptilian, and mammalian predators, as well as abiotic factors. In each year of the study, we documented gray rat snake depredation of Red-cockaded Woodpecker nests. In all three cases, gray rat snakes were observed in the nest cavity and the fledglings disappeared. None of the nestlings were close to the predicted fledging date so it is unlikely they fledged prematurely. Logically, we assumed the rat snakes consumed the nestlings. During the breeding season, we documented gray rat snakes occupying Red-cockaded Woodpecker cavities that were not used for nesting.

We documented five cases of southern flying squirrel depredation of Red-cockaded Woodpecker eggs. In two cases, we observed a flying squirrel in the cavity eating eggs and in three cases a flying squirrel was observed in the cavity with broken egg shells at least three days prior to the predicted hatching date. Although we cannot state conclusively the three later observations demonstrated flying squirrel egg consumption, the two previous observations

strongly suggest the flying squirrels consumed the eggs. We routinely observed southern flying squirrels in Red-cockaded Woodpecker cavities during the breeding season and observed multiple individuals in cavities during the winter months. We also documented a fox squirrel (*Sciurus niger*) in an enlarged cavity used by Red-cockaded Woodpeckers.

In 1999, we observed a Red-tailed Hawk (*Buteo jamaicensis*) remove three nestling Red-cockaded Woodpeckers from a cavity entrance. When nestlings approach fledging, they frequently stick their heads out of the cavity to beg from adults. This behavior enabled the hawk to fly up to the side of the cavity, roll horizontally and grab the nestlings with its talons. The hawk appeared to pause momentarily at the moment of each capture, but it did not grasp the side of the tree from our perspective. To our knowledge, this unusual behavior has not been documented in the scientific literature. In 1999, rain water was responsible for the loss of a Red-cockaded Woodpecker clutch. Water seeped into the cavity and floated the eggs, causing total clutch loss.

We documented 3 cases of depredation on adult Red-cockaded Woodpeckers. The appearance of the kills (i.e., small pile of Red-cockaded Woodpecker feathers with little carcass remaining) suggested depredation by owls or hawks. Two carcasses were found in pine regeneration stands and one carcass was found in a pine beetle spot (i.e., an area where trees had been removed due to pine beetle infestation). Red-cockaded Woodpeckers frequently flew across pine regeneration stands to enter foraging areas, thus increasing the potential for aerial depredation (Jackson and Parris 1995). During the study, we observed Barred Owls (*Strix*

*varia*), Cooper's Hawks (*Accipiter cooperii*), Red-shouldered Hawks (*Buteo lineatus*), and Red-tailed Hawks attempt to catch adult Red-cockaded Woodpeckers on the wing; however, none of these attempts were successful.

Anecdotally, we documented 12 avian species that occupied Red-cockaded Woodpecker cavities at least once. Six species successfully nested (i.e., fledged  $\geq 1$  young) in active Red-cockaded Woodpecker cavities, including Carolina Chickadee (*Poecile carolinensis*;  $n = 4$  nests), Downy Woodpecker (*Picoides pubescens*;  $n = 5$  nests), Eastern Bluebird (*Sialia sialis*;  $n = 2$  nests), Great-crested Flycatcher (*Myiarchus crinitus*;  $n = 9$ ), Red-bellied Woodpecker (*Melanerpes carolinus*;  $n = 13$ ), and Tufted Titmouse (*Baeolophus bicolor*;  $n = 12$ ). Five species successfully nested in inactive Red-cockaded Woodpecker cavities, including American Kestrel (*Falco sparverius*;  $n = 2$ ), Eastern Screech-Owl (*Otus asio*;  $n = 5$ ), Pileated Woodpecker (*Dryocopus pileatus*;  $n = 7$ ), Red-bellied Woodpecker ( $n = 7$ ), and Wood Duck (*Aix sponsa*;  $n = 2$ ). Northern Flicker (*Colaptes auratus*) and Red-headed Woodpecker (*Melanerpes erythrocephalus*) roosted in Red-cockaded Woodpecker cavities but nesting attempts were not observed. Other species documented using Red-cockaded Woodpecker cavities included gray tree frogs (*Hyla versicolor-chrysozelis*), bees, and wasps.

## DISCUSSION

### Reproductive success parameters

Red-cockaded Woodpecker nesting rates at Bienville National Forest were similar to nesting rates reported by

LaBranche and Walters (1994) (75–91%), Carter et al. (1995) (63–94%), and DeLotelle and Epting (1992) (89%). In Oklahoma, Wood (1983) reported the lowest nesting rate of 63% in an isolated population, whereas in Florida, Ligon (1970) reported the highest nesting rate (95%). Single male groups, recently paired woodpeckers, and cavity usurpation accounted for several failures to nest which have been reported by other researchers (Walters 1990, Walters et al. 1992). However, some groups that failed to nest consisted of established pairs and had cavity substrate available for nesting. This suggests other factors such as habitat suitability, physiological condition, or prey availability may be responsible for a lack of nesting activity.

Red-cockaded Woodpecker groups had similar mean clutch sizes and were similar to clutch sizes reported by DeLotelle and Epting (1992) (2.9 eggs), Carter et al. (1995) (3.2 eggs), and LaBranche and Walters (1994) (3.3 eggs). Ortego et al. (1995) reported that larger groups (3–4 adults) had larger clutch sizes (3.1 eggs) than smaller groups (2 adults) (2.6 eggs). We did not observe this trend at Bienville National Forest.

Red-cockaded Woodpeckers at Bienville National Forest exhibited a hatching rate similar to high hatching rates (88%) reported in the literature (Ligon 1970, Jackson 1994). At Bienville National Forest, 6% of Red-cockaded Woodpecker eggs did not hatch, possibly due to infertility, inefficient incubation, or being runt eggs. Approximately 3% of all Red-cockaded Woodpecker eggs, typically found in 4-egg clutches, at Bienville National Forest were runt eggs (Ramey and Jackson 1979). In North Carolina, LaBranche

and Walters (1994) reported that 1.1% of Red-cockaded Woodpecker eggs were runt eggs.

We observed only a 1% loss of nestlings during the first 7–10 days of the nesting cycle, which is lower than the 6% loss reported by LaBranche and Walters (1994) in North Carolina. However, we did observe partial brood loss, by approximately one nestling/nest, from the 10 day mark until fledging. Ligon (1970) suggested that partial brood loss may be attributed to sub-optimal habitat, inadequate prey availability, or predation.

Red-cockaded Woodpecker groups at Bienville National Forest had high fledging rates and fledged approximately two fledglings/nest, which is similar to rates reported in the literature. Carter et al. (1995) and LaBranche and Walters (1994) reported a mean of approximately two fledglings/nest with the highest rate (2.4 fledglings/nest) reported by Engstrom and Sanders (1997) in a longleaf pine ecosystem. Other studies have reported lower fledging rates, such as DeLotelle and Epting (1992) (1.0 fledglings), and DeLotelle et al. (1995) (0.94 fledglings).

## **Mortality**

We observed 3 cases of Red-cockaded Woodpecker nestling depredation by gray rat snakes. Rat snakes are capable of crossing inadequate resin barriers surrounding the cavity entrance created by Red-cockaded Woodpeckers (Jackson 1974, Neal et al. 1993). To prevent climbing of brood trees by rat snakes, mesh snake traps and metal flashing were installed at the base of brood trees during the

course of this study (Krueger 1991, Withgott et al. 1995, Neal et al. 1998).

Although southern flying squirrels typically forage on vegetative and insect matter (Bendel and Gates 1987, Harlow 1990), we observed 5 cases of depredation on Red-cockaded Woodpecker nests by southern flying squirrels. Ortego et al. (1995) documented 4 cases of southern flying squirrels present with Red-cockaded Woodpecker egg fragments in Texas. Mitchell et al. (1999) experimentally removed or excluded southern flying squirrels from Red-cockaded Woodpecker cavities. However, their results were inconclusive as to the impact of southern flying squirrels on Red-cockaded Woodpecker nesting success. Squirrel excluder devices may be necessary in small Red-cockaded Woodpecker subpopulations with high southern flying squirrel populations (Loeb 1996).

### **Cavity kleptoparasitism**

Although we did not quantify the rate of cavity kleptoparasitism of Red-cockaded Woodpecker cavities, we did observe frequent usurpation by southern flying squirrels, Red-bellied Woodpeckers, and other interspecific competitors. Bienville National Forest has a substantial amount of hardwood vegetation in the midstory and occasionally the overstory, which sustains high densities of southern flying squirrels and other potential competitors for cavities. Hardwoods produce mast (e.g., acorns) that frequently appears in the diet of southern flying squirrels (Harlow 1990). However, Conner et al. (1996) determined that cavity use by southern flying squirrels was not related to abundance of hardwood vegetation in Red-cockaded

Woodpecker areas in Texas. Similarly, Red-cockaded Woodpecker fledging success was not correlated with the presence of southern flying squirrels in woodpecker cavities (Conner et al. 1996). However, extensive overlap in use of woodpecker cavities combined with documented predation events suggests that southern flying squirrels may play a role in limiting local Red-cockaded Woodpecker nesting success.

Kappes and Harris (1995) suggested that a greater availability of snags in Red-cockaded Woodpecker areas might result in reduced competition from cavity nesters such as Red-bellied Woodpeckers. However, their data did not confirm this hypothesis. Due to a greater availability of cavities, other cavity nesters may have increased their reproductive success. Thus, the presence of snags in Red-cockaded Woodpecker areas may actually create more competition for cavities over successive breeding seasons, although this has not been documented.

### **ACKNOWLEDGMENTS**

We thank our field technicians for their dedicated work under difficult conditions. We are grateful to the U. S. Forest Service, the Forest and Wildlife Research Center at Mississippi State University, and the Mississippi Cooperative Fish and Wildlife Research Unit for financial support for this research. We thank the Mississippi Department of Wildlife, Fisheries and Parks for their logistical support.

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