

Group size and nest success in Red-cockaded Woodpeckers in the West Gulf Coastal Plain: helpers make a difference

Richard N. Conner,^{1,3} Daniel Saenz,¹ Richard R. Schaefer,¹ James R. McCormick,^{2,4}
D. Craig Rudolph,¹ and D. Brent Burt²

¹ *Wildlife Habitat and Silviculture Laboratory (maintained in cooperation with the Arthur Temple College of Forestry, Stephen F. Austin State University), Southern Research Station, USDA Forest Service, 506 Hayter Street, Nacogdoches, Texas 75965 USA*

² *Department of Biology, Stephen F. Austin State University, Nacogdoches, Texas 75962 USA*

Received 20 September 2002; accepted 14 March 2003

ABSTRACT. We studied the relationships between Red-cockaded Woodpecker (*Picoides borealis*) group size and nest productivity. Red-cockaded Woodpecker group size was positively correlated with fledging success. Although the relationships between woodpecker group size and nest productivity measures were not statistically significant, a pattern of increasing clutch size and number of hatchlings with increasing group size was apparent. The presence of helpers appeared to enhance the survival of nestlings between hatching and fledging. The contribution that helpers make to nestling feeding and incubation, cavity excavation, and territory defense appears to have a positive effect on nest productivity. A threshold number of helpers may be necessary before a significant benefit for fledging success is realized. Nests with four and five group members fledged more young than nests with two or three group members. Whether partial brood loss occurred or not within a nest was primarily a function of clutch size and the number of hatchlings. Although partial brood loss did affect the number of young fledged from individual nests by removing young from nests with high numbers of hatchlings, woodpecker group size appeared to be the primary determinant of fledging success.

SINOPSIS. **Tamaño del grupo y éxito de anidaje de *Picoides borealis*, en el Llano Costanero de la Parte Occidental del Golfo: los asistentes hacen la diferencia**

Estudiamos la relación entre el tamaño de los grupos y la productividad de los nidos del carpintero *Picoides borealis*. En la especie, el tamaño del grupo fue correlacionado positivamente con el éxito de anidamiento. Aunque la relación entre el tamaño de los grupos y la productividad de los nidos no resultó estadísticamente significativa, notamos un patrón de incremento en la camada y pichones nacidos con un aumento en el número de individuos en el grupo. La presencia de asistentes parece mejorar la sobrevivencia de los pichones en el periodo de pichonada a volantón. La contribución de los asistentes en la excavación del nido, incubación, alimentación de los pichones y la defensa del territorio parece tener un efecto positivo en la productividad de las aves. Parece haber un umbral en referencia al número de asistentes con respecto al efecto positivo en el número de aves que dejan el nido. Grupos de cuatro o cinco individuos, produjeron más volantones que nidos con dos o tres miembros. El hecho de que ocurriera una pérdida parcial de la camada, resultó ser una función primaria del tamaño de la camada y del número de recién nacidos. Aunque en algunos nidos, la pérdida parcial de pichones afectó el número que lograron volar (al eliminar individuos de nidos con altos números de recién nacidos), el tamaño del grupo atendiendo el nido pareció ser el factor principal en relación al número de volantones producidos.

Key words: cooperative breeding, fledging success, group size, partial brood loss, Picidae

The Red-cockaded Woodpecker (*Picoides borealis*) is a cooperatively breeding species indigenous to the southeastern United States (Conner et al. 2001). Young woodpeckers, typically

males from previous nesting efforts, often remain with the breeding pair and assist in subsequent nesting efforts by incubating eggs, feeding and brooding young, excavating cavities, and helping to defend the group's territory (Ligon 1970; Lennartz et al. 1987; Walters et al. 1988; Conner et al. 2001). An aggregation of cavity trees, termed the cluster, is defended by a group of woodpeckers. Each group of Red-cockaded Woodpeckers usually produces one clutch per breeding season, but will often nest

³ Corresponding author. Mailing address: Southern Research Station, 506 Hayter Street, Nacogdoches, Texas 75965-3556 USA. Email: cconnerrn@titan.sfasu.edu

⁴ Current address: U.S. Fish and Wildlife Service East Texas Sub-office, USDI, 701 North First Street, Lufkin, Texas 75901 USA.

again during the same breeding season if the first nest fails (LaBranche and Walters 1994; Conner et al. 2001).

Most studies have demonstrated that the presence of helpers in Red-cockaded Woodpeckers has a positive effect on fledging success in the eastern portion of the species range (Lennartz et al. 1987; Walters 1990). One study in Florida, however, indicated that pairs without helpers had a higher fledging success than pairs with helpers (DeLotelle and Epting 1992). LaBranche and Walters (1994) observed that both inviability of eggs and nestling loss contributed to a reduction in Red-cockaded Woodpecker nest productivity.

We studied nest productivity, group size, and partial brood loss in Red-cockaded Woodpeckers in the West Gulf Coastal Plain. We ask several questions: (1) does woodpecker group size affect fledging success, (2) is there a threshold group size necessary to realize a fledging success benefit, and (3) is partial brood loss associated with clutch size, the number of hatchlings, or fledging success?

STUDY AREAS AND METHODS

We studied Red-cockaded Woodpecker nesting biology at 149 nests in longleaf (*Pinus palustris*) and loblolly (*P. taeda*)-shortleaf (*P. echinata*) pine habitats on the Angelina (31°N15'N, 94°N15'W) and Davy Crockett National Forests (31°N21'N, 95°N07'W) in eastern Texas ($N = 48$) during the 1990 and 1991 breeding seasons (Schaefer 1996), in longleaf pine habitat on the Vernon Ranger District of the Kisatchie National Forest (31°01'N, 93°02'W) in west-central Louisiana ($N = 40$) during the 1992 and 1993 breeding seasons (Conner et al. 1999), and again on the Angelina and Davy Crockett National Forests ($N = 61$) during the 1999 and 2000 breeding seasons (McCormick et al. 2004). Cluster areas were checked at least every 5 d for nesting activity by examining each active cavity tree and looking for woodpeckers that flushed from cavity entrances. If no birds were observed flying from the cavity entrance, we scraped and tapped on the cavity trees that had the greatest amount of activity at resin wells in an attempt to flush a woodpecker from the cavity. If an adult bird was observed flying from the cavity or was seen in the area, we inspected the cavity tree by

climbing it and using a flashlight and mechanic's mirror (1990–1993) or with a Tree-Top IITM Peeper Video system (1999–2000) (Richardson et al. 1999). If no nest was found during that regular visit, all trees were examined again for possible nesting at the next inspection. If eggs were found in the cavity, another visit was scheduled for three days later to see if the clutch was complete. Woodpecker group size was determined for each group during April and May of each year by counting group members as they assembled in the morning to commence foraging or as they returned to cavity-tree cluster sites in the evening prior to roosting.

Confirmed Red-cockaded Woodpecker nest cavities were monitored to determine clutch size, initial number of hatchlings, and number of nestlings surviving beyond day 22 as a measure of fledging success. Nestling age was determined using criteria developed by Ligon (1971). To prevent premature fledging that might result from nest disturbance we ceased internal nest inspections at day 22 as required by the U.S. Fish and Wildlife Service. Post-fledging observations of young woodpeckers being fed by adults were used to verify measures of fledging success. The difference between the number of Red-cockaded Woodpecker hatchlings and the number successfully fledged from each nest was used as a measure of partial brood loss.

We used three-way ANOVA (group size $\times$ forest type [longleaf pine versus loblolly-shortleaf pine] $\times$ year) to evaluate possible effects of woodpecker group size on clutch size, number of hatchlings, number of woodpeckers fledged, percentage of eggs hatched, percentage of eggs producing fledglings, the number of hatchling deaths per nest, and the number of hatchling deaths per nest divided by brood size to adjust for varying brood size among woodpecker groups. A type III sum of squares was used because sample sizes among woodpecker group sizes were unequal. The Least Significant Difference (LSD) range test was used to evaluate differences in nest productivity variables among group sizes after it was determined that forest type had no effect on nest productivity. Spearman correlation analysis was used to examine relationships among measures of nest productivity, group size, and the number of hatchling deaths per nest because of the ordinal nature of some variables.

Table 1. Red-cockaded Woodpecker nest productivity measures (mean $\pm$ SE) in relation to woodpecker group size from 106 nests on the West Gulf Coastal Plain of Texas and Louisiana. Common letters across rows indicate nonsignificant differences as determined by a Least Significant Difference test (LSD) following 3-way ANOVA (group size $\times$ forest type $\times$ year).

Nest variable	Group size			<i>F</i>	<i>P</i>
	2 (<i>N</i> = 52)	3 (<i>N</i> = 38)	4 (<i>N</i> = 16)		
Clutch size	3.17 $\pm$ 0.12 ^a	3.37 $\pm$ 0.12 ^a	3.44 $\pm$ 0.26 ^a	1.36	0.26
Number of hatchlings	2.54 $\pm$ 0.13 ^a	2.71 $\pm$ 0.16 ^a	2.75 $\pm$ 0.23 ^a	1.02	0.39
Number of fledglings	1.75 $\pm$ 0.08 ^a	1.92 $\pm$ 0.12 ^a	2.38 $\pm$ 0.18 ^b	3.45	0.02
Percentage of eggs that hatch	0.81 $\pm$ 0.03 ^a	0.80 $\pm$ 0.04 ^a	0.82 $\pm$ 0.05 ^a	0.57	0.64
Percentage of eggs that fledge	0.59 $\pm$ 0.03 ^a	0.59 $\pm$ 0.04 ^a	0.72 $\pm$ 0.05 ^a	1.58	0.20

RESULTS

Of the 149 Red-cockaded Woodpecker groups we studied where both a breeding male and female were present, 129 of these groups (86.6%) attempted to breed and laid eggs in nest cavities. Eighteen of the 129 nests (14.0%) were lost to predation and in two nests the entire clutch failed to hatch. The remaining 109 nests successfully fledged young. Of all the eggs laid in these 109 nests during the six breeding seasons, 74.5% (288 of 373) hatched, and 75.0% (216 of 288) of the hatchlings successfully fledged from nest cavities. Three (0.8%) of the 373 eggs laid were undersized runt eggs, compared to 1.1% observed by LaBranche and Walters (1994). Clutch size for the 109 successful nests averaged ($\pm$ SE) 3.28 ± 0.08 , number of hatchlings averaged 2.64 ± 0.09 , and number fledged averaged 1.94 ± 0.07 . Woodpecker groups averaged 2.72 ± 0.08 adults per group. Inviolate eggs were observed

in 52.3% (58 of 111) of the nests, and partial brood loss was observed in 47.7% (52 of 109) of the nests.

Only three woodpecker groups had five group members, all of which fledged three young, incurred no partial brood loss, and were in longleaf pine habitat. Because of the small sample size for groups with five members, and the fact that their inclusion in analyses would cause empty cells in the ANOVA design, only groups with two to four members (*N* = 106) were included in the three-way ANOVAs. Three-way ANOVA failed to detect an effect of forest type (longleaf pine versus loblolly-shortleaf pine) on measures of nest productivity ($P \geq 0.56$). However, a year effect was detected for the number of hatchlings per nest ($F_{5,82} = 2.84$, $P = 0.02$), the number of hatchling deaths per nest ($F_{5,82} = 2.77$, $P = 0.02$), and the number of hatchling deaths per nest adjusted for brood size ($F_{5,82} = 2.35$, $P = 0.05$).

Woodpecker group size was related to fledging success (Table 1), and was correlated with fledging success ($r_s = 0.34$, $P < 0.001$). Woodpecker groups with four group members fledged more young than groups with two or three group members. There were no significant interactions between forest type and woodpecker group size in any of the analyses. Although there appeared to be a graphic trend for the number of hatchlings to increase with increasing group size (*N* = 109, Fig. 1), this trend was not statistically significant ($r_s = 0.12$, $P = 0.22$).

When viewed as a ratio of number of young fledged per egg invested (*N* = 109), larger woodpecker groups had a higher fledging success per egg invested ($r_s = 0.22$, $P = 0.02$; Fig. 2). This relationship did not exist for the num-

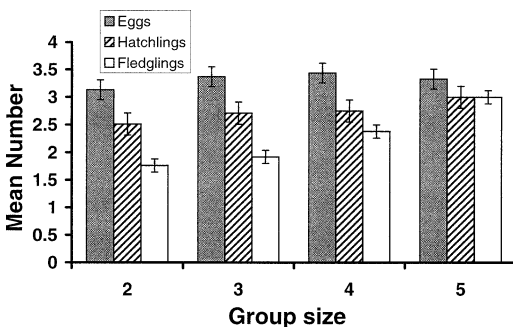


Fig. 1. Red-cockaded Woodpecker nest productivity as measured by mean ($\pm$ SE) clutch size, number of hatchlings, and number of fledglings in relation to woodpecker group size in the West Gulf Coastal Plain of Louisiana and eastern Texas (*N* = 109).

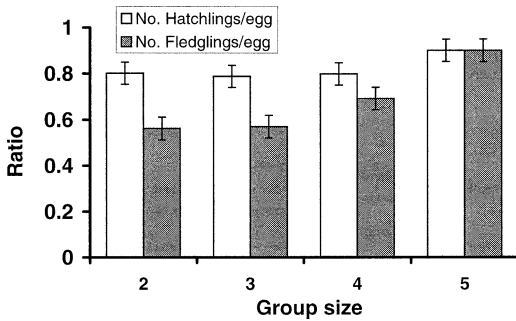


Fig. 2. The ratio (mean $\pm$ SE) of the number of Red-cockaded Woodpecker hatchlings per egg and number of fledglings per egg relative to woodpecker group size in the West Gulf Coastal Plain of Louisiana and eastern Texas ($N = 109$).

ber of young hatched per egg invested ($r_s = 0.03$, $P = 0.74$). After adjusting for brood size, the mean number of hatchling deaths per nest was marginally correlated with woodpecker group size ($r_s = -0.18$, $P = 0.05$).

Partial brood loss (where some hatchlings die prior to the fledging of their siblings) occurred in both Texas and Louisiana. The number of hatchling deaths per nest was positively correlated with clutch size ($r_s = 0.53$, $P < 0.0001$) and the number of hatchlings ($r_s = 0.68$, $P < 0.0001$).

DISCUSSION

Similar to what was previously observed in the eastern United States (Lennartz et al. 1987; Walters 1990), Red-cockaded Woodpecker group size was positively correlated with fledging success in the West Gulf Coastal Plain. Thus, the study by DeLotelle and Epting (1992) in central Florida remains the only study that detected a negative relationship between woodpecker group size and fledging success. The presence of helpers appeared to affect the survival of nestlings between hatching and fledging, i.e., the mean number of young that fledge per nest and the percentage of young that fledge per egg invested. The contribution that helpers make to nestling feeding and incubation, cavity excavation, and territory defense appears to have a positive affect on fledging success (Reed and Walters 1996), and can enhance breeder survival (Khan and Walters 2002).

Our results suggest the possibility that a

threshold number of helpers may be necessary before a significant benefit for fledging success is realized. Although the mean number of young fledged was higher for groups with a breeding pair plus one helper than groups with just a breeding pair, a statistically significant increase in fledging success occurred only after group size increased above three members. However, other factors such as territory quality, group stability, and age and experience of the breeders, which were not measured in our study, can also affect fledging success (Lennartz et al. 1987; Walters 1990; Davenport et al. 2000).

Whether partial brood loss occurred or not within a nest appeared to be primarily a function of clutch size and the number of hatchlings. The more eggs laid, the greater the number of hatchlings, and thus, the greater the probability of partial brood loss. Although partial brood loss did affect the number of young fledged from individual nests by removing young from nests with high numbers of hatchlings, woodpecker group size appeared to be the primary determinant of fledging success.

ACKNOWLEDGMENTS

We thank C. E. Shackelford for help with fieldwork in Louisiana, and N. R. Carrie, N. E. Koerth, M. S. LaBranche, and C. E. Shackelford for constructive comments on an early draft of the paper. Research on the Red-cockaded Woodpecker was done under U.S. Fish and Wildlife Service federal permit TE832201-0 to R. N. Conner. The use of trade, equipment, or firm names in this publication is for reader information only and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

LITERATURE CITED

- CONNER, R. N., D. C. RUDOLPH, R. R. SCHAEFER, D. SAENZ, AND C. E. SHACKELFORD. 1999. Relationships among Red-cockaded Woodpecker group density, nestling provisioning rates, and habitat. *Wilson Bulletin* 111: 494–498.
- , ———, AND J. R. WALTERS. 2001. The Red-cockaded Woodpecker: surviving in a fire-maintained ecosystem. University of Texas Press, Austin, TX.
- DAVENPORT, D. E., R. A. LANCIA, J. R. WALTERS, AND P. D. DOERR. 2000. Red-cockaded Woodpeckers: a relationship between reproductive fitness and habitat in the North Carolina Sandhills. *Wildlife Society Bulletin* 28: 426–434.
- DELOTELLE, R. S., AND R. T. EPTING. 1992. Reproduction of the Red-cockaded Woodpecker in central Florida. *Wilson Bulletin* 104: 285–294.
- KHAN, M. Z., AND J. R. WALTERS. 2002. Effects of help-

- ers on breeder survival in the Red-cockaded Woodpecker (*Picoides borealis*). Behavioral Ecology and Sociobiology 51: 336–344.
- LABRANCHE, M. S., AND J. R. WALTERS. 1994. Patterns of nest mortality in nests of Red-cockaded Woodpeckers in the Sandhills of southcentral North Carolina. Wilson Bulletin 106: 258–271.
- LENNARTZ, M. R., R. G. HOOPER, AND R. F. HARLOW. 1987. Sociality and cooperative breeding of Red-cockaded Woodpeckers, (*Picoides borealis*). Behavioral Ecology and Sociobiology 20: 77–88.
- LIGON, J. D. 1970. Behavior and breeding biology of the Red-cockaded Woodpecker. Auk 87: 255–278.
- . 1971. Some factors influencing numbers of the Red-cockaded Woodpecker. In: The ecology and management of the Red-cockaded Woodpecker (R. L. Thompson, ed.), pp. 30–43. Bureau of Sports Fisheries and Wildlife and Tall Timbers Research Station, Tallahassee, FL.
- MCCORMICK, J. R., R. N. CONNER, D. B. BURT, AND D. SAENZ. 2004. Influence of habitat and number of nestlings on brood reduction in Red-cockaded Woodpeckers. In: Red-cockaded Woodpecker: road to recovery (R. Costa, and S. J. Daniels, eds.). Hancock House, Blaine, WA. In press.
- REED, J. M., AND J. R. WALTERS. 1996. Helper effects on variance components of fitness in the cooperatively breeding Red-cockaded Woodpecker. Auk 113: 608–616.
- RICHARDSON, D. M., J. W. BRADFORD, P. G. RANGE, AND J. CHRISTENSEN. 1999. A video probe system to inspect Red-cockaded Woodpecker cavities. Wildlife Society Bulletin 27: 353–356.
- SCHAEFER, R. R. 1996. Red-cockaded Woodpecker reproduction and provisioning of nestlings in relation to habitat. M.S. thesis. Stephen F. Austin State University, Nacogdoches, TX.
- WALTERS, J. R. 1990. Red-cockaded Woodpeckers: a “primitive” cooperative breeder. In: Cooperative breeding in birds (P. B. Stacey, and W. D. Koenig, eds.), pp. 68–101. Cambridge University Press, Cambridge, UK.
- , P. D. DOERR, AND J. H. CARTER, III. 1988. The cooperative breeding system of the Red-cockaded Woodpecker. Ethology 78: 275–305.