

SIGNS OF TROUBLE IN THE LARGEST REMAINING POPULATION OF RED-COCKADED WOODPECKERS

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ABSTRACT.—The largest remaining population of the endangered Red-cockaded Woodpecker (*Picoides borealis*) occurs in the Apalachicola National Forest in northern Florida, where the U.S. Forest Service has recorded nearly 700 clusters of cavity trees with signs of recent activity by birds (active colony sites). Between January and July 1990 a random sample of 50 of the 186 sites listed by the Forest Service as active in the eastern district of the forest were visited. Thirteen (26%) had been abandoned. Of the 37 sites where birds were present, 14 (>37%) were occupied by single birds. Three of these single birds were members of adjacent clans, and single birds occupied 11 (32%) of the 34 sites that were being defended by their occupants. These percentages might have been different in the western district of the forest. However, the results for the eastern district imply that a population crash may be imminent and that there is an urgent need for management that will provide the mature pine habitat that healthy populations require. Received 2 November 1990, accepted 6 November 1990.

AS A FEDERALLY listed endangered species, the Red-cockaded Woodpecker (*Picoides borealis*) has been subject to management according to two recovery plans specified by the U.S. Fish and Wildlife Service (USFWS 1979, 1985). During this period its numbers continued to decline (Lennartz et al. 1983a, Ligon et al. 1986). The species occurs only in pine forests of the southeastern United States, where it depends on mature living pine trees, in which it excavates its roosting and nesting cavities. As with populations of the Spotted Owl (*Strix occidentalis*) in the northwestern United States (Dawson et al. 1987), one of the reasons for decline is that the area of habitat formerly suitable for the Red-cockaded Woodpecker has been greatly reduced by the clear-cutting and short rotation practices of the timber industry (Wood et al. 1985). Another reason is changes in land use and the exclusion of fire, a practice that favors the successional replacement of pines with hardwoods. The virtual elimination of old-growth pine habitats in the south is apparently the primary cause of the decline in Red-cockaded Woodpeckers (Lennartz et al. 1983b). By the 1980s most populations on private land had disappeared, and responsibility for the species had fallen to federal agencies, primarily the U.S. Forest Service.

A report by Conner and Rudolph (1989) of rapid declines of Red-cockaded Woodpeckers in three national forests in east Texas in the mid-1980s brought renewed urgency to this

conservation crisis. In March 1989, in response partly to this report, partly to a federal suit charging that the U.S. Forest Service was in violation of the Endangered Species Act in Texas, and partly to new evidence of continuing declines in most other populations, the U.S. Forest Service initiated a restriction on clear-cutting trees within three quarters of a mile of any cluster of cavity trees that showed signs of recent activity by the birds. Exceptions were allowed in the national forests that had been estimated to have >250 clusters (colony sites). These forests are the Apalachicola (ANF) in northern Florida, the Francis Marion in South Carolina, and the Kisatchie in northern Louisiana.

Each site (cluster of cavity trees) is the core of a territory that is, or once was, defended by its occupants (Lennartz et al. 1987, Walters 1989). It can potentially support one pair of birds, their recent offspring, and one or more helpers (usually their male offspring from previous years). Each member of this group roosts at night in its own cavity. In the 1985 recovery plan (U.S. Fish and Wildlife Service 1985), the estimate that an effective population size of 250 pairs constitutes a population genetically viable in the long term (Franklin 1980, Lande 1988) was used to justify setting the criterion of 250 breeding units as sufficient to justify declaring that a population had recovered. In fact, not all pairs breed every year, and the number of pairs necessary for an effective population size of 250

pairs may be as high as 500 pairs (Reed et al. 1988). In addition, a substantial number of active sites are likely to be occupied by single birds, so the number of active clusters of trees needed to support a genetically viable population varies among populations, but in all cases it must be substantially higher than 250. The 1985 recovery plan (U.S. Fish and Wildlife Service 1985) also states that beyond the 4-ha core of the territory that includes the cavity trees, but within 0.8 km of each cluster, the birds shall be provided with 51 ha of foraging habitat, of which 60% is at least 30 yr old and the remaining 40% is at least 60 yr old. The U.S. Fish and Wildlife Service (1985, 1989) believes that compliance with this plan would provide sufficient protection so that the species would recover to the point of having 15 populations of at least 250 pairs of breeding adult birds.

The U.S. Forest Service estimates trends in the number of Red-cockaded Woodpeckers largely on the basis of surveys that involve counting and mapping cavity trees and scoring them as active or inactive. A tree with a cavity that is "active" (being used for roosting or nesting) will have fresh resin wells and dripping sap (Jackson 1978, Hooper et al. 1980). When forest management units (compartments) are surveyed systematically for a second time, previously overlooked clusters of cavity trees (colony sites) may be found, abandoned clusters of cavity trees may be found to have been reoccupied, formerly active ones may be found to be inactive, and newly established clusters may be identified. However, the establishment of new clusters (sites) by the birds is apparently a rare event (Walters 1989). Doerr et al. (in press) found only 6 cases in a 9-yr study of 241 active clusters in North Carolina. The annual probability of budding off a new cluster from an existing one was 0.004. In better habitat in South Carolina, Hooper (pers. comm.) recorded a higher rate.

The most recent report on the status of the Red-cockaded Woodpecker in national forests indicates that most populations show signs of decline (Costa and Escano 1989). In 1986 there were 2,115 active sites in national forests, of which 1,326 were in the three forests. Apalachicola had 23%, Francis Marion 23%, and Kisatchie 17% (Costa and Escano 1989). No population was listed as having increased in recent years, only three were reported as stable, and

one as stable to increasing. The largest population was acknowledged to be in the Apalachicola National Forest, which had 487 active sites at the time the information was compiled. Since that time additional management units have been surveyed, and the estimate of active sites has risen to 693 (Costa pers. comm.). On 22 September 1989, Hurricane Hugo destroyed large areas of the Francis Marion National Forest, jeopardizing its rather substantial fraction of the total population. United States Forest Service summaries for 1989 stated that 32% (693 of 2,157) of the Red-cockaded Woodpecker sites in national forests occur in the Apalachicola National Forest. However, the total of 2,157 included all active sites in the Francis Marion National Forest *before* Hurricane Hugo, so at present substantially more than one third of the active sites in the national forests must be in the ANF.

U.S. Forest Service surveys are conducted on a rotation of several years. Generally 10% of management units (compartments) in a forest are checked in any one year. Repeated surveys of randomly selected management units can provide information about trends in the population. Such a survey by Balboni in 1981 (Costa pers. comm.) in the ANF showed a 10% decrease in active sites. However, Hovis and Labisky (1985) showed in a more intensive study that 40 groups on a 5,000-ha study area in the Apalachicola Ranger District (western half of the ANF) may have increased in the 10-yr period of the study (Labisky pers. comm.). Recent stepped-up systematic surveys by compartments have indicated to U.S. Forest Service managers that the population in the Apalachicola district may be increasing but that the population in the Wakulla district is decreasing (R. Costa, R. Escano, pers. comm.).

Using a table of random numbers, I drew a random sample of 50 from the 186 sites listed in April 1989 as presently active in the U.S. Forest Service records for the Wakulla Ranger District (eastern half of the ANF). Between January and July 1990, pairs of observers visited each site at dawn and dusk several times to check trees for signs of activity by birds and to count the birds present at each site. We found no sign of recent Red-cockaded Woodpecker activity, and no woodpeckers present, at 13 (26%) (Table 1). A systematic search within one-quarter mile of each of the unoccupied sites revealed

TABLE 1. Occurrence of the Red-cockaded Woodpecker in 1990 at 70 clusters of cavity trees (colony sites) in the Wakulla Ranger District of the Apalachicola National Forest. (A) 50 sites were randomly selected from the 186 sites located and recorded as being occupied by resident birds (active) as of April 1989 on the most recent surveys by the U.S. Forest Service, all between 1981 and 1988; (B) 20 sites were randomly selected from the 95 sites listed as inactive by the U.S. Forest Service; (C) Estimated number of pairs and of active sites in the Wakulla Ranger District of the Apalachicola National Forest (see text).

	Number	Percentage	95% confidence limit
A. 50-colony sample in 1990 (U.S.F.S. active)			
Sites with birds	37/50	74%	82.3% or lower
Sites with pairs (with or without helpers)	23/50	46%	56.5% or lower
Sites with birds that were occupied by single birds	14/37	37.8%	24.5% or higher
Defended sites that were defended by single birds	11/34	32%	19.3% or higher
B. 20-colony sample (U.S.F.S. inactive)			
Sites with birds	1/20	5%	
Sites with pairs	1/20	5%	
C. Estimates for the Wakulla District (U.S.F.S. active plus inactive)			
Estimated active sites	$(0.74 \times 186) + (0.05 \times 95) = 142.4$		
Estimated pairs	$(0.46 \times 186) + (0.05 \times 95) = 90.3$		

no sign that the groups had moved to new cavity trees nearby and no evidence that new sites were being established. Of the 37 sites with birds, 14 (37.8%) were occupied by single birds and 23 (62%) by pairs, some of which were accompanied by helpers. Thus, of the original 50 sites, 74% had birds (were in fact active) and 46% were occupied by pairs with or without helpers.

The 74% rate observed in the random sample is compatible with a possibly higher rate for the 186 sites as a whole. Calculations based on the hypergeometric distribution (see Appendix), which is applicable here, show that one can have 95% confidence that no more than 153 (82.3%) of the 186 sites are occupied. The reason is that, if there were more than that, the random sample would, with probability 0.95, show more than 37 out of 50 to be occupied. Similarly, the upper 95% confidence limit on the number of sites occupied by pairs is 82 (56.5%). Again, if more than that many were so occupied, then the random sample would almost certainly (with more than a 95% probability) have shown more than 23 out of 50.

An important characteristic of a stable population of Red-cockaded Woodpeckers is a low percentage of single birds (Walters et al. 1988). Because both helpers and single birds are usually males, a high percentage of single birds may indicate poor habitat, a shortage of females, or both. Of the 37 sites with birds, the 37.8% occupied by single birds is a high value compared with 11% in the Sandhills of North Car-

olina (Walters et al. 1988) and even the 23% in the rapidly declining populations in Texas (Conner and Rudolph 1989). The true percentage of sites with birds that are occupied by single birds in the Wakulla Ranger District may be smaller than 37.8%. Because reference to tables of the binomial distribution (Harvard Univ. Press 1955) with some interpolation shows that the 0.05 significance level occurs at the value $P = 0.245$, one can assert with 95% confidence that, among occupied sites, the fraction occupied by single birds is at least 24.5% and that the true fraction is probably higher (Table 1).

The fact that 26% of sites listed by the U.S. Forest Service in 1989 as active were in fact inactive in 1990 implies but does not confirm that the population is declining. Their records summarize an ongoing survey of the entire forest, and all sites had been visited since 1981. The percentage of active sites that were occupied by single birds at the time of their previous survey is unknown, but the fact that, in the breeding season of 1990, 11 of 34 defended sites (32%) were occupied by single birds is cause for concern. Part of this high figure may be attributable to U.S. Forest Service overestimates of the number of active colonies in compartments that have not been surveyed recently. Conner and Rudolph (1989), Walters et al. (1988), and Doerr et al. (in press) have found in other populations that single birds are usually males and that abandonment often follows after 1-3 yr of presence of only a single bird.

In the breeding season of 1989, we studied

40 of these same sites. Twenty-eight of the 40 were occupied by birds, and 8 of the occupied sites (28.5%) were occupied by single birds. Of the 8 single birds, 4 were defending their sites (the others were members of adjacent groups that used the site only for roosting). In 1990, 29 of the 40 sites were occupied and 11 (37.9%) of the sites with birds were occupied by single birds. The number of defended sites that had single birds rose from 4 of 24 (16.7%) in 1989 to 8 of 26 (30.8%) in 1990. We also studied a random sample of 20 of the 95 sites listed as inactive by the U.S. Forest Service. Of these sites, one was occupied by a pair of birds. In combination with the 1990 breeding-season data, the data on sites listed as inactive allow an estimate of 142 active sites and 90 pairs of birds for the Wakulla Ranger District in the 1990 breeding season (Table 1c).

This study was conducted in the eastern district of the Apalachicola National Forest. We have not studied the adjacent western district, where 73% of the sites listed as active by the U.S. Forest Service have been recorded. However, our results show that many sites in the Wakulla Ranger District listed as active by the U.S. Forest Service are not presently occupied by birds and that only about half of them are occupied by pairs. The high percentage of sites that are being defended by single birds suggests that the population is probably declining.

ACKNOWLEDGMENTS

I thank L. Kennedy, E. Goldman, R. Hutchinson, M. Kinnison, M. Evans, B. Kotrla, R. West, and K. Rebello for assistance with fieldwork. L. E. Moses assisted with data analysis. W. Baker, R. Escano, R. T. Engstrom, J. Jackson, R. Conner, D. Simkerloff, and J. Walters made comments on drafts of the manuscript.

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APPENDIX

To assess how many sites occupied by pairs of birds there might reasonably be, in light of our random sample, which showed 23 out of 50 so occupied, we write what we know and what we don't know in this form:

	With pair	Without pair	Total
Observed	23	27	50
Not observed	x	$136 - x$	136
Total			186

How large might x become before the results are inconsistent (at a one-sided significance level of 0.05) with random sampling? We find $x = 82$ is the answer (which can be confirmed if Chi-square is computed for two tables:

Total			and	Total		
23	27	50		23	27	50
82	54	136		83	53	136

Total 105 81 186 106 80 186

82 is the largest value for x that is not inconsistent (at one-sided $P = 0.05$) with random sampling, and our upper 95% confidence for the percentage of active sites that have pairs of birds is $(23 + 82)/186 = 56.5\%$.

Similarly, the table

	Occupied	Not occupied	Total
Observed	37	13	50
Not observed	x	$136 - x$	136
Total			186

becomes significant at $x = 116$, giving 153 for the 95% upper bound for occupied sites, corresponding to 82.3%.