THE RED-COCKADED WOODPECKER ON THE SAVANNAH RIVER SITE: ASPECTS OF REPRODUCTIVE SUCCESS

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Abstract: The red-cockaded woodpecker (*Picoides borealis*) population on the Savannah River Site has been closely monitored and studied over the past 17 years. In 1985, the USDA Forest Service Southern Research Station was given responsibility to study and manage this population in an effort to prevent its extirpation. In December 1985, there were only 4 individuals on the site: 1 pair and 2 solitary males. The population had increased to a total of 175 individuals in 42 active clusters in 2002. Although this represents a very successful recovery effort, there has been substantial annual variation in nesting survival from banding to fledging. Data were analyzed to more completely understand the factors affecting reproduction. No significant effects of age of the breeding male and female, years paired, number of helpers, habitat quality, number of nestlings, and time of nest initiation were found when comparing reproductive success in 117 nesting attempts from 1999 to 2002. However, the number of neighboring groups had a direct effect on mortality rates, possibly demonstrating the importance of cluster spacing.

Key words: brood loss, group density, intraspecific competition, longleaf pine ecosystem, nesting success, red-cockaded woodpecker, reproduction, Savannah River Site, South Carolina.

Over the past 25 years, the red-cockaded woodpecker has been the subject of extensive research and management efforts. Although much has been learned about the biology of this species, several questions arose in 2002 at the Savannah River Site (SRS) concerning reproductive success. During the 2002 breeding season there were relatively high rates of nestling mortality between banding and fledging. Our data conflict with Sanders (2000) findings, which suggested the mortality rate before the banding date to be 3.5 times greater than after the banding date.

Reproductive success was significantly correlated with intrusion rates in central Florida (DeLotelle and Epting 1992). The majority of these territorial intruders were female (76%). There were also documented losses of 2 nests from destruction of eggs suggesting conspecific interaction (R. DeLotelle, DeLotelle and Guthrie, Inc., personal communication). There has also been an observation of live nestlings being removed from a nest by a red-cockaded woodpecker of unknown status on the Francis Marion National Forest (U.S. Forest Service, personal communication). Similar observations of increased nesting failures associated with the presence of red-cockaded woodpeckers that were neither breeders nor helpers were observed at SRS. Intraspecific strife has been documented for wood ducks (*Aix sponsa*) resulting in destruction and removal of eggs as well as adult hen injury and mortality between host and intruding females (Belrose and Holm 1994).

In an attempt to understand the variation in nestling survival rates, we analyzed reproductive data from the past 4 years (1999-2002), examining effects of age of breeding male, breeding female, number of years paired, number of helpers, banding date, age of young lost, number of neighboring groups, and habitat quality. Our objective was to identify possible factors influencing survival of red-cockaded woodpecker nestlings.

STUDY SITE

The SRS, a National Environmental Research Park, comprises 80,271 ha (198,137 acres) located within portions of Aiken, Allendale, and Barnwell Counties in South Carolina (Figure 1). The SRS lies in the Upper Coastal Plain physiographic region and is within the historical range of the longleaf pine (*Pinus palustris*) ecosystem (Frost 1993). The site was purchased by the Atomic Energy Commission in 1950 as a nuclear weapon material production facility (Savannah River Forest Station History 1966). At that time, the majority of the site was used for agriculture or harvested for timber. The Department of Energy (DOE) charged the U.S. Forest Service with management of the natural resources in 1951 (Savannah River Forest Station History 1966). In 2000 the Savannah River Forest Station (currently the U.S. Forest Service-Savannah River) delineated 34,832 ha (86,069 ac) as a red-

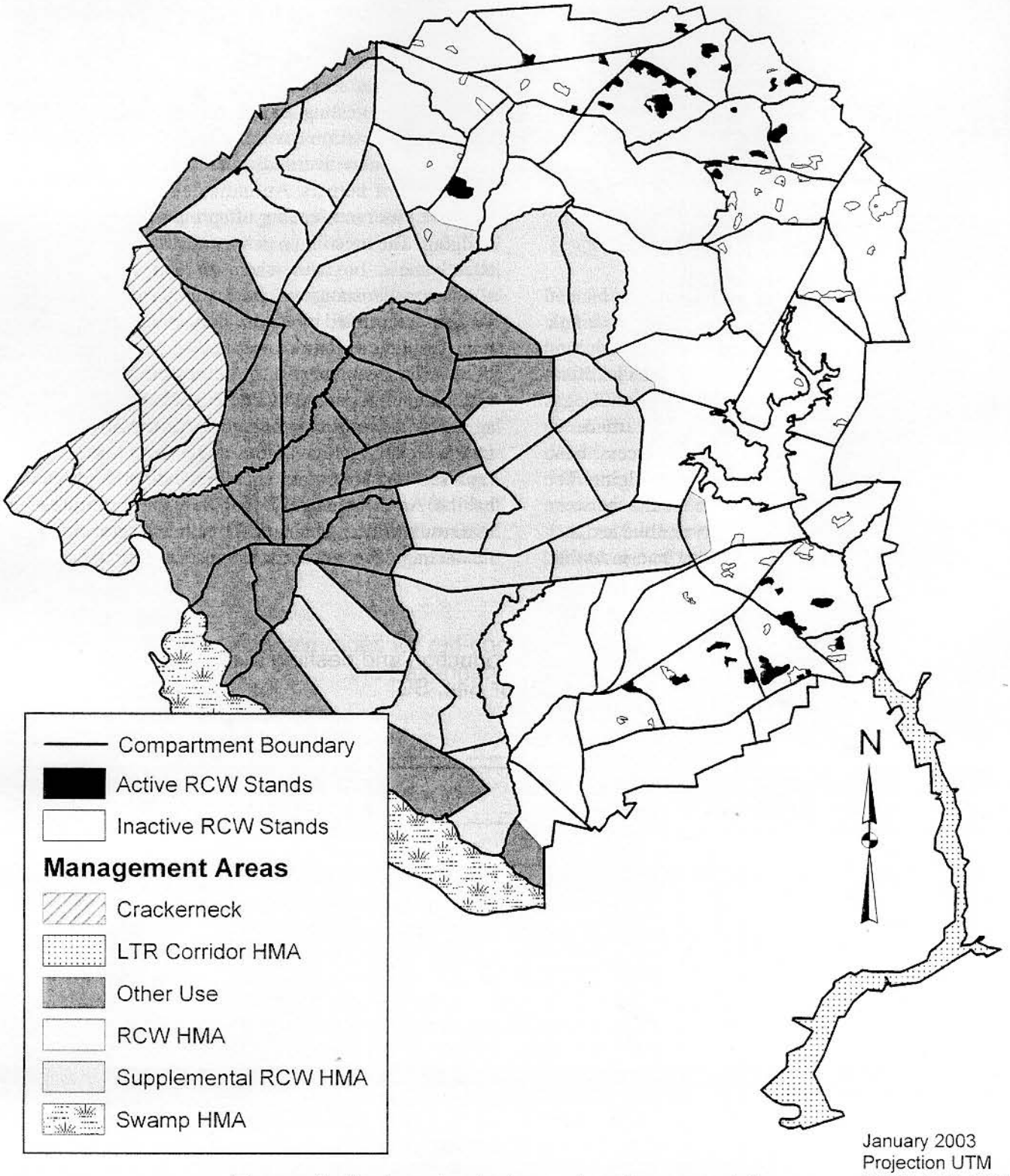


Figure 1. Red-cockaded woodpecker population on the Savannah River Site, South Carolina

cockaded woodpecker habitat management area (HMA) and an additional 19,493 ha (48,167 ac) as a supplemental red-cockaded woodpecker HMA. These areas included a combined 38,924 ha (96,180 ac) dominated by loblolly (*Pinus taeda*) and longleaf pine, averaging < 50 years in age. This area of potential red-cockaded woodpecker habitat has a long-term goal of 418 active clusters.

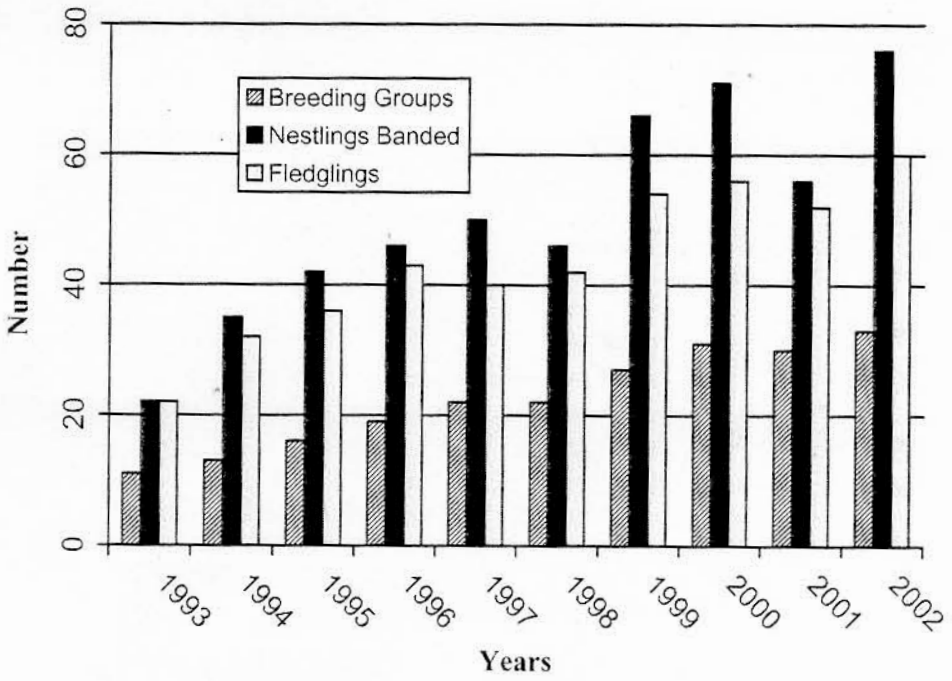
METHODS

Each individual red-cockaded woodpecker was banded with a unique combination of color bands and a single U.S. Geological Survey (formerly, U.S. Fish and Wildlife Service) band that allowed for field identification. Nest checks were made twice a week until eggs were found. Subsequent nest visits were made to determine total clutch size and hatching success, band the nestlings, determine sex, and confirm fledging. The age of the young was estimated as the median between the period when the young were observed alive and then observed dead or missing for nests that had mortality. Two nesting attempts in which the young were never banded were also included, and in this case the age of the 2 unbanded young was approximated and the data were treated as all other nesting attempts. These data described 117 nesting attempts from 1999 to 2002.

Observations were conducted during the nesting season to identify the breeding pair and presence or absence of helpers. An individual was counted as a helper if observed feeding offspring in the nest or after fledging. The breeding pair was identified based on nest attentiveness. In cases where there were more than 2 adults, breeder status was carried over from the previous year, or determined by observation of social interactions (e.g., displays of dominance).

The habitat within the cluster was quantified and assigned a numeric value based on the density and age of pines, presence of midstory, and abundance of ground cover. Habitat values range from 1 to 5, with 1 representing low, and 5 representing high-quality habitat. Annual changes in habitat value for some areas as a result of fire, mechanical treatment, or other habitat treatments were taken into consideration.

Figure 2. Red-cockaded woodpecker reproduction and nestling survival on the Savannah River Site, SC



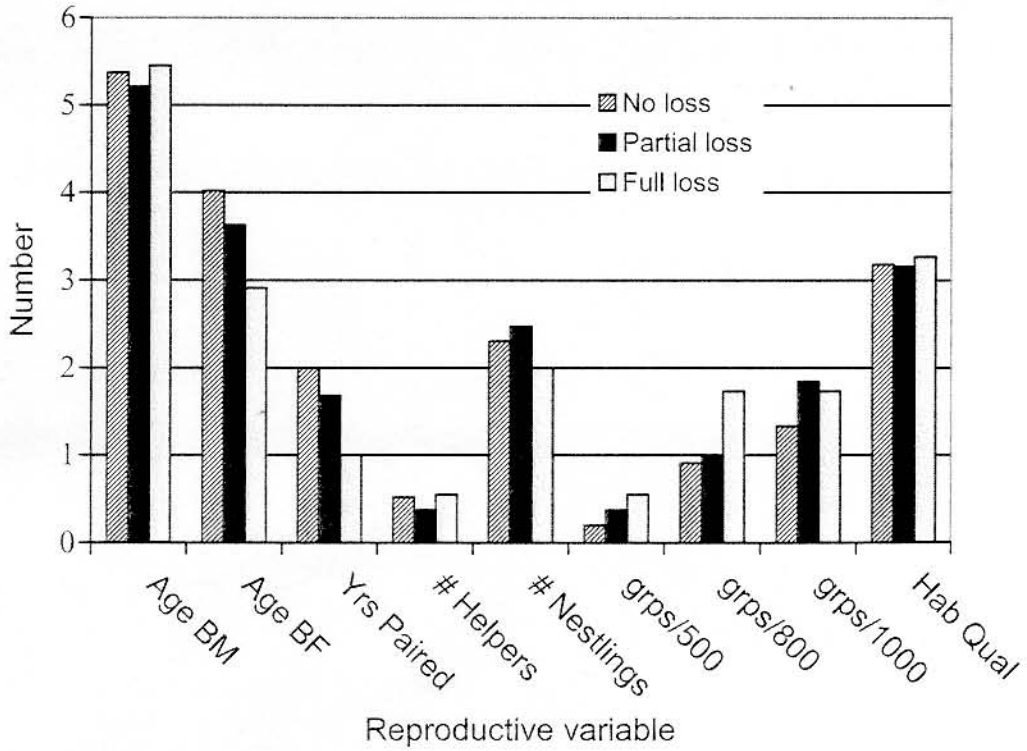
The number of neighboring groups within 500 m, 800 m, and 1000 m was determined for each group using geographical information systems (GIS). The distances between respective nesting trees were measured to determine the distance between groups. The approximate center of the tree cluster was used as a reference point for groups with no breeding activity in a given year.

Two dependent parameters (number of nestlings lost and proportion of nestlings lost to total number of nestlings) were compared to the independent variables (listed above). We used a general linear model (GLM) analysis (SAS Institute 1996), because no obvious relationship between the dependent and independent variables merited other approaches (e.g., quadratic, non-linear, etc). Initially, our analysis included year as a class variable, but it was discarded along with several other variables, (e.g., banding date, habitat quality [hab qual], age of young lost, number of years paired [yrs paired]) because they did not contribute significantly to the model solution. A GLM was used to relate actual number of nestlings lost and proportion of nestlings lost to age of breeding male and female (age BM, age BF), number of helpers (# helpers), number of nestlings (# nestlings), and the number of neighboring groups within 500, 800, and 1000m (grps500, grps800 and grps1000) of other groups. The effect of neighboring groups on nestling loss was independently evaluated using a series of student t-tests.

RESULTS

We found survival rates of nestlings between banding and fledging of 77.8% and 78.9%, for 2000 and 2002, respectively (Figure 2). This contrasted with survival rates that averaged 87.3% over the last 10 years on SRS (1993-2002) and 86.8% over 9 years on Marine Corps Base Camp LeJeune, North Carolina (1993-2001) (J. Walters, Virginia Polytechnic Institute and State University, personal communication). Comparing averages between nesting attempts with no loss, partial loss, or full loss of the nest, 4 of the 9 variables (years paired, age of breeding female, number of neighboring

Figure 3. Variable averages for red-cockaded woodpecker nesting attempts at the Savannah River Site, SC



groups within 500m, number of neighboring groups within 800m) demonstrated noticeable trends (Figure 3). The average age of breeding females experiencing no loss was 4.0 years, partial loss was 3.6 years, and total loss was 2.9 years. Similarly, the average number of years paired was 2.0 for no loss, 1.7 for partial, and 1.0 for full nest loss. Finally, partial and full nest loss increased with more neighboring groups present at all distances, with the exception of full nest loss for a radius of 1000 m.

The number of neighboring groups was significantly related to nestling mortality between banding and fledging ($P < 0.05$) (Table 1). The age of breeding females also tended to be related to nesting success ($P < 0.1$) when comparing the number of neighboring groups within 800 m and 1000 m. Additionally, the number of helpers was marginally significant ($P < 0.1$) when comparing nestlings lost and groups within 800 m. Nestling survival rates were significantly related to total number of nestlings ($P < 0.1$). The date of nest initiation, number of years paired, and habitat index were not significant in any combination of variables or year. Although the number of years paired was consistently less for groups that experienced loss, it was insignificant in the statistical analysis.

DISCUSSION

Our results suggest that nestling loss after banding may be related to intraspecific competition of red-cockaded woodpeckers, both within the nest and outside. The significance of the number of nestlings to overall nestling mortality indicated competition within the nest. The food provided by adults is rationed among nestlings. Competition increases with the number of nestlings, as the amount of available food per young decreases.

Outside of the nest, competition between adults resulted in nestling mortality as the number of neighboring groups increases. We believe that areas with high numbers of groups in close proximity result in aggressive behavior between neighboring pairs. Effort is spent defending the territory instead of provisioning nestlings. The impact of neighboring groups on reproduction was significant within 500 m and 800 m of the nest tree, but insignificant at 1000 m. Competition may have been compounded by relatively low rainfall over the past few years, as the lack of rain may have had a negative effect on arthropod populations.

Age of the breeding female was correlated with nesting success, whereas the age of the breeding male

Table 1. Results from general linear model of selected variables for nestling loss of red-cockaded woodpeckers, Savannah River Site, South Carolina, 1999-2002 (n = 117). Numbers represent coefficients and their significance. F-values and probability of significance reflect statistical performance of each conditional model. Values in bold are significant at P = 0.05, Values underlined are significant at P = 0.1

	Nestlings Lost			Percent Survival		
Variable	Grps/500m	Grps/800m	Grps/1000m	Grps/500m	Grps/800m	Grps/1000m
Age BM	0.0063	0.0138	0.0193	-0.0010	-0.0049	-0.0075
Age BF	-0.0540	-0.0653	-0.0624	0.0237	0.0279	0.0279
# Helpers	-0.1316	-0.1840	-0.1531	0.0100	0.0287	0.0213
# Nestlings	0.1934	**0.2154**	0.1848	N/A	N/A	N/A
# Groups	**0.3834**	**0.1560**	0.0803	**-0.1796**	**-0.0644**	-0.0342
Intercept	0.0951	0.0195	0.0732	0.7772	0.7895	0.7920
F-value	2.28	2.16	1.47	2.80	2.23	1.48
Probability	0.0515	0.0639	0.2049	0.0295	0.0699	0.2128

was not significantly correlated. The importance of the breeding female's age is not clear. However, because helpers tend to be male there would normally be an excess of females, assuming the gender ratio is equal (on the SRS in 2002, we had 59 adult females to 56 adult males). We had 2 documented helper females, leaving 57 adult females to compete for a breeding position in 42 groups. In contrast, there were 13 male helpers, and 43 males competing for breeding positions in 42 groups. Therefore, we suggest that the competition for breeding positions among females is greater than among males.

Our results suggest that younger, less experienced breeding females tend to have reduced reproductive success. This may be due to aggressive interactions between breeding females and neighboring or alien females that result in reduced nest attentiveness, resulting in nestling mortality. Likewise, younger breeding females may be displaced by older birds when foraging. In addition, an intruding female may attempt to facilitate an opportunity to breed by destroying a nest, hoping to pair with the male in a subsequent nesting attempt. This was supported by data showing that 12 of 20 failed breeding attempts from 1998-2001 were associated with a change in the breeding female the following year.

Competition with southern flying squirrels (*Glaucomys volans*) did not appear to be a factor influencing reproductive success. Prior to 2002, we had an intensive regime of monitoring cavities, removing squirrels throughout the year. We discontinued flying squirrel control in half of the groups in 2002 in an effort to understand their impact on reproduction and found no correlation with nest loss. Although we had 1 confirmed case of nest loss due to squirrels, overall competition with flying squirrels did not appear to have a significant impact on the reproductive success of the birds in 2002. We plan to continue this experiment and evaluate the need for squirrel control in the future.

CONCLUSION

Our data suggest that there are various factors that can influence nestling mortality after banding. These factors appear to be interrelated and vary by year, group, and location. However, at SRS the number of neighboring groups within 800 m was the only variable that significantly influenced nestling mortality. From a management perspective, the distance between groups is important at SRS, and should be closely examined when managing for populations with similar habitat limitations. Group spacing is highly dependent on habitat quality, which prevents the establishment of a quantitative standard. High quality habitat provides good forage, but may stimulate competition when quantity of habitat is limited.

Further research on this population is needed to more completely understand the relationship between reduced reproduction and intraspecific competition. Visual confirmation of this hypothesis would help to substantiate the potential of conspecific nest destruction. Continued monitoring with this question in mind could also clarify the larger issue of intraspecific competition in red-cockaded woodpecker populations.

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