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# SUCCESS OF INTENSIVE MANAGEMENT OF A CRITICALLY IMPERILED POPULATION OF RED-COCKADED WOODPECKERS IN SOUTH CAROLINA

KATHLEEN E. FRANZREB
*USDA Forest Service*
*Southern Research Station*
*Department of Forest Resources*
*Clemson University*
*Clemson, South Carolina 29634-1003 USA*

Abstract.—By late 1985, the population of Red-cockaded Woodpeckers (*Picoides borealis*) at the Savannah River Site, South Carolina, had declined to a low of four individuals. Because of extensive timber harvesting prior to the 1950s, the older live pine trees that Red-cockaded Woodpeckers require for cavity construction were limited. We monitored the response of the population to intensive habitat enhancement that included construction of artificial cavities, control of cavity competitors, and removal of the hardwood mid-story to improve nesting habitat quality. Translocations of Red-cockaded Woodpeckers from on-site and donor populations were undertaken to enhance the number of breeding pairs, the overall population size, and to minimize potential adverse genetic consequences of a small population size. From 1986–1995, we carried out 54 translocations, installed 305 artificial cavities, and removed 2304 southern flying squirrels (*Glaucomys volans*) (a cavity competitor). Concomitant intensive population monitoring revealed that the number of breeding pairs of woodpeckers increased from 1 to 19 and the overall population size grew from 4 to 99 individuals, reflecting the highly focused habitat restoration effort. Intensive management has been successful in rehabilitating this critically small population of endangered birds.

**EXITO EN EL MANEJO INTENSO DE UNA POBLACIÓN EN RIESGO DE *PICOIDES BOREALIS* EN CAROLINA DEL SUR**

Sinopsis.—Para fines del 1985, la población de *Picoides borealis* en el área del Río Savannah en Carolina del Sur se había reducido a un mínimo de cuatro individuos. Debido al cosecho intenso de madera previo a la década del 1950 los pinos antiguos que *Picoides borealis* requieren para construír cavidades eran limitados. Monitoreamos la respuesta de la población a un proceso intenso de mejoras de hábitat que incluyó la construcción de cavidades artificiales, el control de competidores por cavidades, y la remoción del sotobosque medio leñoso para mejorar la calidad del habitat de anidaje. Se llevó a cabo traslocación de individuos de *Picoides borealis* de la localidad y de poblaciones donantes para aumentar el número de parejas reproduciéndose, el tamaño total de la población, y para minimizar las posibles consecuencias genéticas de una población pequeña. Entre 1986 y 1995 llevamos a cabo 54 traslocaciones, instalamos 305 cavidadaes artificiales, y removimos 2304 individuos de *Glaucomys volans* (un competidor por cavidades). Monitoreo intensamente concomitante de la población reveló que el número de parejas reproductivamente activas aumentó de 1 a 19 y la población total creció de 4 a 99 individuos, reflejando el efecto del esfuerzo intenso en restaurar el hábitat. El manejo intenso ha sido exitoso en rehabilitar esta críticamente pequeña de aves en peligro de extinción.

The Red-cockaded Woodpecker evolved in a fire-dependent pine ecosystem within the southeastern United States. Extensive clearing for agriculture or timber by the early 1900s (Krusac et al. 1995), coupled with a fire-prevention ethic that emerged in the 1930s resulting in a significant reduction in fire, further reduced the amount and distribution of habitat that was suitable for the Red-cockaded Woodpecker. Major reasons for

the Red-cockaded Woodpecker population decline include hardwood encroachment around cavity trees (Conner and Rudolph 1989, Costa and Escano 1989, Locke et al. 1983, Loeb et al. 1992, Van Balen and Doerr 1978), extensive clearcutting (Conner and Rudolph 1989, Jackson 1986, Ortego and Lay 1988), shortage of potential cavity trees (Hooper 1988, Costa and Escano 1989, Rudolph and Conner 1991), and demographic isolation (Costa and Escano 1989). Population growth may be restricted by habitat quality and competition for a limited number of cavities (Copeyon et al. 1991, Walters et al. 1992a,b). In 1970, the U.S. Fish and Wildlife Service designated the Red-cockaded Woodpecker as an endangered species (35 *Federal Register* 16047, 13 October 1970) primarily as the result of widespread modification and loss of its habitat and range, its apparent rarity, and declines in local populations.

The population of Red-cockaded Woodpeckers at the Savannah River Site, South Carolina, represented just one of numerous populations that had undergone drastic declines and were close to being extirpated. Although the historical population size of the Red-cockaded Woodpecker at the Savannah River Site is not known, by the end of 1985 the population had declined to four individuals, consisting of a breeding pair and two other single males. Red-cockaded Woodpeckers on the Savannah River Site were faced with a two-fold dilemma because trees that were suitable for new cavity construction were scarce and older trees that had cavities were becoming senescent and dying. In addition, there was evidence of competition with numerous species for the limited number of cavities. The objectives of this paper are to examine the responses of a critically endangered population to a concerted recovery effort designed to thwart local extirpation.

## METHODS

*Study area.*—The Savannah River Site is a 80,269 ha nuclear-production facility that was established in 1951 under the jurisdiction of the Department of Energy. The site lies within the Upper Coastal Plain Physiographic Region, in Aiken, Allendale, and Barnwell counties, South Carolina. Under an interagency agreement, the Savannah River Forest Station (U.S. Department of Agriculture, Forest Service) manages the natural resources of the site.

Aerial photographs document that before 1950, approximately 60% of the land on the site was used for agricultural purposes. Beginning in the 1950s an intensive reforestation program was initiated that encompassed the entire site except for administrative and nuclear production facilities, emphasizing replanting of longleaf (*Pinus palustris*), loblolly (*P. taeda*), and slash (*P. elliotti*) pines (J. Dent., pers. comm. in DeFazio et al. 1987). Currently, approximately 50,000 ha are in pine stands, 15,000 ha are hardwood stands, and 4000 ha are mixed pine-hardwood stands (Workman and McLeod 1990). The majority of pines are now less than 50 yr of age.

*Midstory control and artificial cavities.*—To minimize midstory development that can cause Red-cockaded Woodpeckers to abandon cavities,

a prescribed burning program was initiated in 1985 at the Savannah River Site. In addition to prescribed burning, commercial thinning and other mechanical means as well as herbicide application were employed to create and maintain suitable nesting habitat. The initial emphasis was on restoring and maintaining nesting habitat in active (those clusters with one or more Red-cockaded Woodpeckers) and inactive clusters (those with no woodpeckers present). In 1989, the focus shifted to restoring previously unoccupied stands that are within 4.8 km of active clusters.

From 1985–1996, a total of 2182 ha ($\bar{x}$ = 181.8 ha/yr) of active clusters, inactive clusters, and recruitment stands (a recruitment stand is an area that does not contain a woodpecker group but that has been treated for midstory control and has been fitted with artificial cavities) at the site were treated with some form of midstory control (W. Jarvis, pers. comm.). Because some sites required more than one treatment, the actual treated acreage is more than the figures reflect. Specific treatment procedures included broadcast applications of herbicide, cutting stems with chainsaw or brushsaw, and cutting stems followed by herbicide stump treatments. Intermediate and co-dominant pines in the overstory were treated mainly with commercial thinning to reduce the remaining pine basal area to 13.8–18.3 $m^2$ per ha. In the early years of the program (1985–1990), most of the prescribed burning was done only in small areas to enhance nesting habitat. In later years larger areas have been treated to improve foraging and nesting habitat.

From 1986–1996, 305 artificial cavities were installed by Forest Service personnel for use by roosting and nesting Red-cockaded Woodpeckers at the site (292 are still usable). Details of the design, construction, and installation are provided in Allen (1991). Cavities were fitted with metal plates to prevent other species, especially Red-bellied (*Melanerpes carolinus*) and Pileated (*Dryocopus pileatus*) Woodpeckers from enlarging cavity entrances and usurping the cavities.

*Control of southern flying squirrels.*—The need to remove southern flying squirrels (*Glaucomys volans*) from cavities at the Savannah River Site was recognized by DeFazio et al. (1987) as they posed a threat to efforts to expand the woodpecker population. In an attempt to limit squirrel use of Red-cockaded Woodpecker cavities, nest boxes were affixed to the sides of cavity trees in April 1986 (DeFazio and Lennartz, 1987). Cavities in cavity trees and squirrel nest boxes were checked regularly (generally once per month). Any flying squirrels encountered during these checks were destroyed by cervical dislocation after pulling them from the cavity using a flexible mechanics tool equipped with a pinching device at one end or removing them by hand from the nest boxes. Active clusters, inactive clusters, and recruitment stands were included in the squirrel monitoring program.

*Monitoring and population status and trends.*—Intensive monitoring of the Red-cockaded Woodpecker population at the Savannah River Site has been underway since 1985. All cavities, whether natural (e.g., constructed by the Red-cockaded Woodpecker) or artificial, were monitored year-

round to determine whether they were being used by Red-cockaded Woodpeckers or other species. The observer secured a Swedish climbing ladder on the front of the cavity tree and then climbed the tree using prescribed safety measures. Cavity checks using a dentist's mirror and flashlight that could be inserted into the cavity provided data on number of eggs, number of nestlings, laying and hatching dates, and sex of nestlings. Number of fledglings was determined by observing the cluster area frequently at the predicted time of fledging based on hatching dates.

All adults on the site were banded with a U.S. Fish and Wildlife Service aluminum leg band and with a unique color plastic leg band combination so that they could be identified in the field. Birds were banded either as nestlings or when first captured on the site. All woodpeckers that have been translocated from other populations were banded prior to being released at the site.

Population status, reproductive success, spatial distribution, and group composition were derived from the group and cavity check data. Survivorship and mortality were determined during monthly observations of groups throughout the year. During the breeding season (April–July) monitoring efforts were intensified and each group was observed weekly. As Red-cockaded Woodpeckers return nightly to roost individually in cavities in their respective clusters, the status of individual birds can usually be ascertained by visiting the roost trees either in the evening when birds return to roost or early in the morning prior to the birds emerging. Observations of each group provided information on survival, sex ratio, number of helpers, number of active/inactive pairs, location of nests, identity of breeding adults, fledging dates, number and sex of fledglings, and reproductive success.

## RESULTS

Red-cockaded Woodpeckers readily accepted the artificial cavities and successfully reproduced in them. From 1986–1995, 54 Red-cockaded Woodpeckers were translocated from either off-site (donor) populations ($n$ = 21) or within the Savannah River Site ($n$ = 33) using different experimental strategies into clusters provisioned with artificial or natural cavities (Franzreb, unpubl. data). The goal of these translocations was to provide a mate to an established breeding bird who had lost its partner or to form a new pair in unoccupied territory. Results for the initial 16 translocations were reported in Allen et al. (1993) and the outcome of the 54 translocations in Franzreb (unpubl. data). Thirty-one of 49 translocations involving subadult and adult Red-cockaded Woodpeckers were successful as defined by the bird remaining at the release site or closeby for at least 30 d after being released, and 51.0% of the translocated birds have reproduced (Franzreb, unpubl. data). Five additional translocations of nestlings were conducted which produced one success.

Prior to the first translocations of Red-cockaded Woodpeckers in 1986 at the Savannah River Site, flying squirrel activity had been monitored on a regular basis by climbing all trees in all active clusters; it was rare to

find a squirrel in a Red-cockaded Woodpecker cavity (DeFazio and Lennartz 1987). However, in April 1986, an increase in the number of flying squirrels was detected in all active Red-cockaded Woodpecker clusters. During 1986 when nest boxes were first installed and monitored, 15 of 98 (15.3%) squirrels that were detected were able to escape. Removing squirrels from natural and artificial cavities using the mechanics tool was far easier and resulted in less than a 5% escape rate. A total of 2304 southern flying squirrels have been removed and destroyed from artificial cavities, natural cavities, and nest boxes at the Savannah River Site (Table 1). On an annual basis, cavity inspections varied from a low of 282 in 1986 to a high of 4594 in 1995. We removed 1511 squirrels from artificial cavities, 652 from natural cavities, and 141 from nest boxes. The number of squirrels removed per inspection has varied ranging from 0.07–0.29 squirrels removed/cavity inspected (Table 1). By 1995, the percent of flying squirrels found in nest boxes had declined to a low of 2.8% ($n$ = 527 flying squirrel captures). Because nest boxes in recent years had become only marginally effective, monitoring of nest boxes was discontinued in late 1995.

After the 1985 breeding season, there were ten Red-cockaded Woodpeckers at the site (Figure 1), although the population subsequently declined to four birds by late 1985 (Gaines et al. 1995). With the exception of 1987 and 1988, in which the number of birds was stable, the population has grown every year, increasing to 21 active groups and a total of 99 individuals by the end of the breeding season in 1996 (Table 2). Of these 21 groups, there were 19 breeding pairs of which 16 were reproductively successful, producing 43 fledglings (Table 2).

Except for 1988, the number of fledglings produced has increased yearly (Figure 2) and has varied from 3 to 43 (Table 2). During most years, male fledglings outnumber females; however, in 1988 all fledglings were female (Figure 2). The mean fledging success for 1985–1996 based on the number of fledglings/successful nesting attempt was 2.3 and ranged from a low of 1.6 in 1991 ($n$ = 8 nesting attempts) to a high of 3.0 in 1985 ($n$ = 1 nesting attempt). In 1991, one pair nested twice, successfully fledging one young each time. Successful double-clutching is a rarely observed in this species (Labranche et al. 1994).

## DISCUSSION

Typical Red-cockaded Woodpecker nesting habitat consists of an open, mature pine stand with little hardwood midstory and with relatively low pine basal areas ranging from 11.5–18.4 $m^2$ ha (Gaines et al. 1995). Increasing hardwood midstory development may cause Red-cockaded Woodpeckers to abandon clusters once the midstory attains a certain height and basal area (Conner and Rudolph 1989, Costa and Escano 1989, Hooper et al. 1991, Loeb et al. 1992). Historically, fires that occurred every 3–5 yr and most frequently during the growing season (Krusac et al. 1995), were largely responsible for limiting hardwood encroachment and maintaining the pine and pine-hardwood ecosystems in which

TABLE 1. Southern flying squirrel removal program at the Savannah River Site, South Carolina (1986–1996).

| | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of cavity or box inspections | 282 | 515 | 640 | 588 | 900 | 1300 | 1500 | 1600 | 1449 | 4594 | 4492 | 17,860 |
| No. of artificial cavities available | NA[a] | 17 | 28 | 28 | 33 | 48 | 101 | 151 | 195 | 245 | 292 | 292 |
| No. of squirrels removed from artificial cavities | NA | 3 | 43 | 47 | 49 | 54 | 70 | 97 | 135 | 430 | 583 | 1511 |
| No. of squirrels removed from natural cavities | 69 | 24 | 83 | 49 | 58 | 35 | 34 | 38 | 32 | 82 | 148 | 652 |
| No. of squirrels removed from nest boxes | 14 | 35 | 22 | 4 | 3 | 5 | 16 | 7 | 20 | 15 | NA | 141 |
| No. of flying squirrels removed during inspections | 83 | 62 | 148 | 100 | 110 | 94 | 120 | 142 | 187 | 527 | 731 | 2304 |
| No. squirrels removed per inspection | 0.29 | 0.12 | 0.23 | 0.17 | 0.12 | 0.07 | 0.08 | 0.09 | 0.13 | 0.12 | 0.16 | 0.13 |

[a] NA = not applicable.

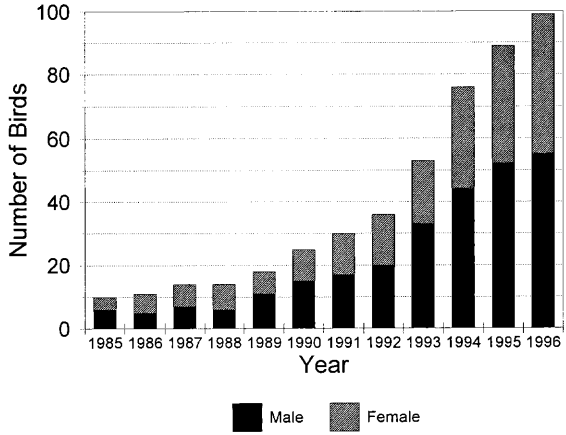


FIGURE 1. Sex ratio and population growth in response to intensive management of Red-cockaded Woodpeckers at the Savannah River Site, South Carolina (1985–1996).

the Red-cockaded Woodpecker evolved (Foti and Glenn 1991, Landers 1987, Landers et al. 1990, Runkle 1991). Hardwood midstory control (prescribed burn, cutting, and use of herbicides) that mimics the natural fire regime has been an essential component of the conservation of the Red-cockaded Woodpecker at the Savannah River Site.

The use of Red-cockaded Woodpecker cavities by other species has been previously documented (Harlow and Lennartz 1983, Jackson 1978, Loeb 1993, Loeb and Stevens 1995, Rudolph et al. 1990). On the Noxubee National Wildlife Refuge, flying squirrels extensively used Red-cockaded Woodpecker cavities (Richardson and Stockie 1995). Richardson (unpub. data cited in Richardson and Stockie 1995) report that in most cases, Red-cockaded Woodpeckers reoccupied cavities after the flying squirrels were removed by hand. Rudolph et al. (1990) examined competition for roosting and nesting cavities in a Texas population of Red-cockaded Woodpeckers in longleaf pines. They concluded that competition for cavities during the time prior to the breeding season was not an important consideration.

In earlier Red-cockaded Woodpecker work conducted at the Savannah River Site, DeFazio and Lennartz (1987) suggested that, "Removal of dramatic influxes of squirrels from a colony in one month may decrease the number of squirrels found in that colony during the following two months." However, it was not clear from their report whether flying squirrels had an impact on woodpecker reproduction. Because of the small population size of Red-cockaded Woodpeckers at the Savannah River Site, it would not be feasible to compare reproductive success in clusters with active squirrel monitoring to those without squirrel removal. An assessment of the efficacy of this activity was needed to determine if the costly and time-consuming squirrel monitoring program should be continued.

TABLE 2. Annual reproductive data and population growth (1985–1996) for the Red-cockaded Woodpecker at the Savannah River Site, South Carolina.

| Year | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | Mean no./yr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of: | | | | | | | | | | | | | |
| Active groups[a] | 5 | 3 | 3 | 4 | 4 | 7 | 8 | 10 | 11 | 13 | 18 | 21 | 8.9 |
| Breeding pairs | 1 | 2 | 3 | 2 | 4 | 5 | 6 | 8 | 11 | 13 | 17 | 19 | 7.6 |
| Nesting attempts | 1 | 2 | 3 | 2 | 5 | 6 | 8 | 11 | 15 | 14 | 20 | 24 | 9.3 |
| Successful pairs | 1 | 2 | 3 | 2 | 4 | 5 | 6 | 5 | 9 | 13 | 16 | 16 | 6.8 |
| Successful pairs-1st nest | 1 | 2 | 3 | 2 | 4 | 6 | 5 | 4 | 7 | 13 | 13 | 13 | 6.1 |
| Successful pairs-2nd nest | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 1 | 2 | 0 | 3 | 3 | 1.1 |
| Successful nests | 1 | 2 | 3 | 2 | 4 | 5 | 7 | 5 | 9 | 13 | 16 | 16 | 6.9 |
| Eggs laid | 3 | 7 | 9 | 7 | 14 | 23 | 30 | 35 | 46 | 54 | 77 | 83 | 32.3 |
| Hatchlings | 3 | 5 | 7 | 7 | 11 | 15 | 24 | 24 | 26 | 38 | 50 | 57 | 22.3 |
| Fledglings | 3 | 4 | 7 | 4 | 8 | 9 | 11 | 13 | 22 | 32 | 36 | 43 | 16.0 |
| Reproductive rate: | | | | | | | | | | | | | |
| Fledglings/breeding pair | 3.0 | 2.0 | 2.3 | 2.0 | 2.0 | 1.8 | 1.8 | 1.6 | 2.0 | 2.5 | 2.1 | 2.3 | 2.2 |
| Fledglings/successful pair | 3.0 | 2.0 | 2.3 | 2.0 | 2.0 | 1.8 | 1.8 | 2.6 | 2.4 | 2.5 | 2.3 | 2.7 | 2.3 |
| Fledglings/nesting attempt | 3.0 | 2.0 | 2.3 | 2.0 | 1.6 | 1.5 | 1.4 | 1.2 | 1.5 | 2.3 | 1.8 | 1.8 | 1.9 |
| Fledglings/successful nest | 3.0 | 2.0 | 2.3 | 2.0 | 2.0 | 1.8 | 1.6 | 2.6 | 2.4 | 2.5 | 2.3 | 2.7 | 2.3 |
| Sex ratio-fledglings (M/F) | unk | 2:2 | 3:4 | 0:4 | 5:3 | 5:4 | 3:8 | 6:7 | 14:8 | 17:15 | 20:16 | 21:22 | 96:93 |
| Total population size[b] | 10 | 11 | 14 | 14 | 18 | 25 | 30 | 36 | 53 | 76 | 89 | 99 | |

[a] Includes single bird clusters.
[b] Post-breeding season peak.

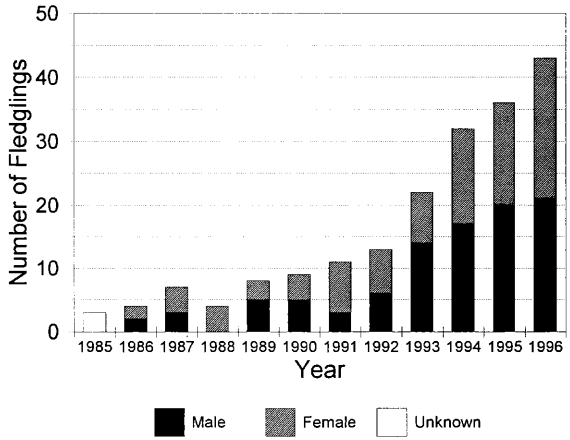


FIGURE 2. Number and sex ratio of Red-cockaded Woodpecker fledglings produced at the Savannah River Site, South Carolina (1985–1996).

To address this question, a controlled experiment to test whether southern flying squirrels adversely affect reproductive success of Red-cockaded Woodpeckers was recently completed in the Carolina Sandhills National Wildlife Refuge in eastern South Carolina, a habitat that is similar to the Savannah River Site (e.g., Upper Coastal Plain). Results suggested that Red-cockaded Woodpecker groups that nested in areas in which flying squirrels had been removed by ground trapping and during cavity checks produced significantly more fledglings than control clusters during both years of this study (1994 and 1995) (Laves and Loeb 1996; Laves unpubl. data). At the Savannah River Site, the reproductive rates were 2.5 in 1994 and 2.1 in 1995 and were similar to that found in the Sandhills study for clusters in which flying squirrels had been removed. The fact that the reproductive rates were similar in the treated Savannah River Site and Sandhill populations suggests that flying squirrel removal has had a beneficial effect on woodpecker reproduction in the Savannah River Site population.

Although we removed a large number of flying squirrels to limit cavity competition with the Red-cockaded Woodpecker at the Savannah River Site, a more effective, less labor intensive technique was needed. A method to minimize flying squirrel access to actual or potential Red-cockaded Woodpecker cavities was developed by Montague et al. (1995). The squirrel excluder device, or SQED, consists of paired strips of aluminum flashing stapled tightly to the bark above and below the cavity entrance. In an experiment of this new device on the Ouachita National Forest, west-central Arkansas, squirrels abandoned 6 of 10 cavities that had been treated by installing excluder devices and Red-cockaded Woodpeckers reoccupied 10 of the 11 cavities (one treated cavity was not occupied previously by squirrels) (Montague et al. 1995). Their results provide indirect

evidence that occupation of cavities by flying squirrels may preclude use by Red-cockaded Woodpeckers. Recently SQEDs were tested at the Savannah River Site in unoccupied Red-cockaded Woodpecker clusters and results indicated that the devices were effective in impeding cavity use by flying squirrels (Loeb, in press). As of yet, Red-cockaded Woodpeckers have not used these SQED-treated cavity trees at the Savannah River Site which may be because these trees are in habitat that was previously unoccupied by woodpeckers. Also, debris (e.g., twigs, moss, etc.) that was brought into the cavities by the squirrels was not removed when the SQEDs were affixed to the trees, a procedure that Montague (pers. comm.) believes would have made the cavities more attractive to woodpecker use. Testing of SQEDs at the Savannah River Site is now being expanded to include active clusters.

The research on the Red-cockaded Woodpecker population at the Carolina Sandhills National Wildlife Refuge in which squirrel removal benefited Red-cockaded Woodpecker reproductive success, the similar woodpecker reproductive rates between the Savannah River Site and Carolina Sandhills clusters that had undergone squirrel removal, and the high rate of reoccupancy of Red-cockaded Woodpecker cavities on cavity trees that were treated with squirrel excluder devices (Montague et al. 1995) indicate that squirrel presence may be deleterious to woodpecker recovery. Although there is no direct evidence specific to the Savannah River Site regarding the impact of flying squirrels on woodpecker reproductive success, the results of these studies suggest that continued efforts to monitor and exclude flying squirrels at this site are warranted.

Mean reproductive rates for Red-cockaded Woodpecker populations elsewhere within the range, based on the number of fledglings/successful nesting attempt, are variable and include 2.1 for the Carolina Sandhills, North Carolina (Carter et al. 1995), 1.3 in Florida (DeLotelle and Newman 1983), 1.5 in Florida (Ligon 1970), 1.6 in coastal South Carolina (Lennartz et al. 1987), 1.9 in Texas (Lay et al. 1971), and 1.7 in the Georgia Piedmont (Lennartz and Heckel 1987). At the Savannah River Site, the relatively high mean reproductive rate of 2.3 fledglings per successful nesting attempt, suggests a high degree of effectiveness for the focused management approach to this population.

Two other studies have documented stimulation of population growth in small populations of Red-cockaded Woodpeckers. On the Noxubee National Wildlife Refuge, Mississippi, the population had declined to 16 active clusters in 1986. From 1990–1992, installation of cavity inserts, creation of recruitment stands, removal of nest predators and competitors, and hardwood midstory control increased the population to 32 active clusters (Richardson and Stockie 1995). In the St. Marks National Wildlife Refuge, Florida, the population had declined to four birds by 1982. Of the two pairs and one single male that were translocated there in 1984 and 1986, one female remained and bred successfully producing nine fledglings over four years, more than all other pairs combined. By 1992, the population had increased to 21 birds, largely the result of the repro-

ductive influence of this one female (Reinman 1995). The Savannah River Site research described herein included the management activities done on the Noxubee refuge, plus the translocation approach used on the St. Marks refuge. Based on these studies, it is clear that intensive management is an effective tool in halting declines in seriously depleted small populations and in stimulating population growth in Red-cockaded Woodpeckers.

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