REINTRODUCTION AND POSTRELEASE MOVEMENTS OF RED-COCKADED WOODPECKER GROUPS IN EASTERN TEXAS

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Abstract: **The effects of demographic isolation may be particularly severe in small, isolated populations of the endangered red-cockaded woodpecker (*Picoides borealis*). Augmentation of single adult woodpeckers with subadult birds of the opposite sex allows managers to stabilize small, isolated populations but does not provide a means to significantly increase populations. The reintroduction of pairs of subadult red-cockaded woodpeckers into unoccupied habitat provides a technique to bolster small populations. We report the results of such efforts to increase a small, isolated red-cockaded woodpecker population in eastern Texas, and we describe postrelease movements of translocated red-cockaded woodpeckers. Seventeen red-cockaded woodpeckers (9 M, 8 F) were translocated to the Sabine National Forest in eastern Texas between December 1994 and March 1995. Prior to translocations, this forest contained 13 groups of red-cockaded woodpeckers. Five pairs, consisting of a subadult male and female, were released to attempt to establish new breeding pairs. Seven additional subadult woodpeckers were translocated to provide mates to solitary individuals. Nine previously unoccupied sites were occupied. Of the 17 woodpeckers translocated, 12 (71%; 6 M, 6 F) were established in territories following the 1995 or 1996 breeding seasons. The remaining 5 woodpeckers were unaccounted for. Of the 12 woodpeckers resighted, 3 (18%) established territories at their release sites. Woodpeckers that dispersed from their release site were relocated in sites an average of 2.8 km (range = 0.5–9.6 km) away. One (20%) of the 5 pairs released remained together into the 1995 breeding season. Eight (89%) of the 9 new pairs found during 1995 and 1996 included at least 1 translocated red-cockaded woodpecker and bred during 1995 or 1996. Our results demonstrate that the direct reintroduction of multiple pairs is an effective technique for reestablishing breeding units in formerly vacant habitat. Our results also suggest the reintroduction of pairs in a spatial array dense enough to allow social contact between adjacent pairs and with preexisting clusters substantially increases the formation of new pairs.**

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The endangered red-cockaded woodpecker is endemic to the pine forests of the southeastern United States (Jackson 1971). The species is a cooperative breeder, living in groups consisting of a breeding pair and ≤4 helpers, which are usually male offspring from previous breeding seasons (Ligon 1970, Lennartz et al. 1987, Walters et al. 1988). Each group inhabits and defends an aggregate of cavity trees (known as a cluster site) and associated foraging habitat (Hooper et al. 1980, 1982). Causes of population decline include loss of-old-growth pines for cavity excavation (Rudolph and Conner 1991, U.S. Fish and Wildlife Service 1985), encroachment of hardwood midstory (Locke et al. 1983, Conner and Rudolph 1989), and habitat fragmentation (Conner and Rudolph 1989, 1991).

Demographic isolation resulting from deforestation, fragmentation of remaining forested habitat, and past population decline also contributes to the continuing decline of many populations (Conner and Rudolph 1991, Rudolph and Conner 1994). The effects of demographic isolation may be particularly severe in small populations (Conner and Rudolph 1989, 1991) where few young are produced and where immigration of woodpeckers from other populations is inadequate to offset losses of breeding adults. In such instances, a red-cockaded woodpecker that loses its mate may remain single until it either abandons the site or dies. Defazio et al. (1987) developed the technique of augmenting single males with a subadult female red-cockaded woodpecker, thus reestablishing a

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breeding pair. This technique has since been used extensively throughout the range of the species. in 1990, the process was successfully expanded to include the transport of young males to single females (D. K. Carrie, U.S. For-, est Service, unpublished data).

Augmentation, of single red-cockaded 'woodpeckers allows managers to slow the decline of small, isolated populations bwt depends upon the presence of an unpaired bird; hence, this technique does not provide a means of significantly increasing these populations. The successful reintroduction of 2 pairs of subadult red-cockaded woodpeckers into unoccupied habitat (Rudolph et al. 1992) provided a technique for bolstering small populations. Subsequent reintroduction 'attempts throughout the Southeast have consisted of the release of single pairs of birds into vacant habitat and have met with varying success (U.S. Forest Service, unpublished data). Rudolph et al. (1992) recommended releasing multiple pairs of red-cockaded woodpeckers into sites near each other end near established groups to facilitate social interaction between the introduced birds and residents. Here, we report the results of such an effort to increase a small, isolated red-cockaded woodpeeker population in eastern Texas, and we describe postrelease movements of the translocated red-cockaded woodpeckers. .

METHODS

This study was conducted on the 63,923-ha Sabine National Forest in eastern Texas (31°30′ N, 93°45′ W). Loblolly (*Pinus taeda*) and shortleaf (*P. echinata*) pine dominate the northern half of the forest, and longleafpine (*P. pal&t&*) is predominant throughout much of the' southem half. The red-cockaded woodpecker population on the Sabine National Forest has remained small but stable since 1987, declining from 14 groups in 1987 to 13 in 1994 (Conner et al. 1995).

Prior to 1995, the northern half of the Sabine National Forest contained 5 woodpecker groups. Although 3 of these groups are <1 km from each other, they are >10 km from the other 2 groups, which limits opportunities for interaction. The southern half of the forest contained 3 areas with 1, 2, and 5 groups each. Distances between the 3 areas ranged from 5 to 15 km, again limiting potential interaction between woodpeckers from these areas. Areas between the 2 sets of groups in the northern region and near the single group in the southern region were targeted for reintroduction efforts to supplement the population and reduce isolation of existing groups.

We selected inactive cluster sites or recruitment stands as release sites. Recruitment stands are areas managed by the U.S. Forest Service to provide potential nesting habitat for population expansion. Because red-cockaded woodpeckers typically disperse after release, sites selected to receive birds had ≥3 recruitment stands or abandoned clusters within 1 km, distributed around the selected release site. All release sites and surrounding recruitment stands and abandoned clusters were provisioned with 3–4 artificial cavity inserts (see Allen 1991). The hardwood midstory had been removed in all sites within the past 5 years, and all areas were prescribed burned every 3–4 years. Prior to and following releases, southern flying squirrels (*Glaucomys volans*) were 'removed from all sites to minimize their competition for red-cockaded woodpecker cavities. Subadult red-cockaded woodpeckers were obtained from the Sam Houston National Forest, Texas, and the Kisatchie National Forest, Louisiana. We considered subadult red-cockaded woodpeckers those individuals that were <1 year old and that had 'not gone through their first breeding season. Subadult birds were translocated in the fall and winter following completion of their first molt. We used ' standard translocation techniques (DeFazio et al. 1987; Rudolph et al. 1992). Prior to release, all red-cockaded woodpeckers were banded with a unique combination of colored leg bands' and a U.S. Fish and Wildlife Service leg band. Two pairs were released either at the same time or within the shortest possible time interval at sites 1–2 km apart and <2 km from already established social groups.

Following release, we monitored all sites for signs of activity on cavity trees (Jackson 1978). We identified red-cockaded woodpeckers following release by using a spotting scope to read colored leg-band combinations. Red-cockaded woodpeckers were monitored into the following breeding season to assess movements between sites and interactions among released and resident birds. If individuals remained single for >3 weeks and did not appear to be interacting with other red-cockaded woodpeckers, a bird of the opposite sex was translocated to the site. Efforts to provide single woodpeckers with mates resulted in the translocation of 5 additional single

birds (3 M, 2 F) besides the original 5 pairs. A male was also released alone to determine whether he would remain at the release site where he could be later provided with a female. A resident adult male that had lost its mate the previous year was provided a female.

We monitored translocated red-cockaded woodpeckers during the 1995 and 1996 breeding seasons to determine whether pairs attempted to nest and to measure nest success. Monitoring typically involved visiting clusters ≤3 times during the nesting season to look for eggs or nestlings. Following the 1995 and 1996 breeding season, all red-cockaded woodpeckers in release areas were captured to confirm the locations of translocated individuals.

RESULTS

Group Formation

Following the release of the 17 subadult red-cockaded woodpeckers (9 M, 8 F) on the Sabine National Forest between December 1994 and March 1995, 9 previously unoccupied recruitment stands or cluster sites were occupied by red-cockaded woodpeckers (Fig. 1). Eight of these new groups were created in the 4 targeted release areas (see rectangles l-4, Fig. 1).

Of the 17 red-cockaded woodpeckers translocated, 12 (71%; 6 M, 6 F) were established in territories following the 1995 or 1996 breeding seasons. Red-cockaded woodpeckers usually dispersed from the release site, but 3 of the 12 birds remained at their release sites. Woodpeckers that dispersed from their release site were relocated in sites an average of 2.8 km away (range = 0.5-9.6 km). One (20%) of the 5 pairs released remained together into the 1995 breeding season. Eight (89%) of the 9 new pairs found during 1995 and 1996 included ≥1 translocated woodpecker and bred during 1995 or 1996. A new group formed by an unbanded male and female outside the release areas also bred successfully in 1995. A male that dispersed from his release site occupied a cluster with a subadult female, but no breeding was observed in 1995 or 1996. To summarize, 5 new breeding pairs included 1 translocated bird in each pair; both members of 3 new breeding pairs were translocated birds, and 1 new breeding pair had no translocated birds. The remaining 5 of the 17 released birds were unaccounted for.

Movements of Released Birds

A subadult female that was released to a single male in release area 1 subsequently paired with a different single male in a nearby cluster site and bred in 1995 and 1996 (see rectangle 1, Fig. 1). A different pair occupied the original release site in 1995. Release of 1 female combined with a resident female precipitated the formation of 2 breeding groups where 2 single males had previously occurred.

Two pairs of red-cockaded woodpeckers and a male were released in release area 2 in the southern portion of the Sabine National Forest (see rectangle 2, Figs. 1, 2). Four of the 5 woodpeckers moved from their release sites. One of the woodpeckers that moved paired with the bird that remained at its release site, and 2 others paired with birds elsewhere to replace an existing pair and reactivate another cluster. Release of 5 red-cockaded woodpeckers combined with 2 of the 3 resident birds resulted in the formation of 3 breeding pairs in this area.

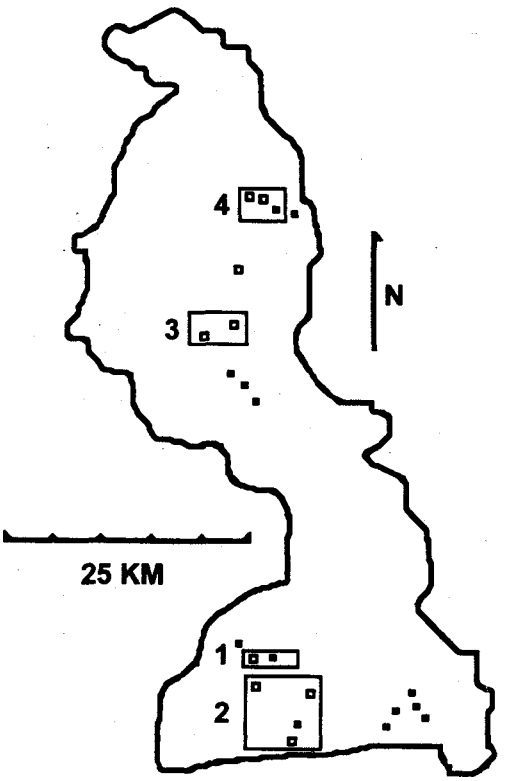


Fig. 1. The distribution of new and preexisting groups of red-cockaded woodpeckers on the Sabine National Forest, Texas. Rectangles (l-4) represent areas where reintroductions and translocations were conducted.

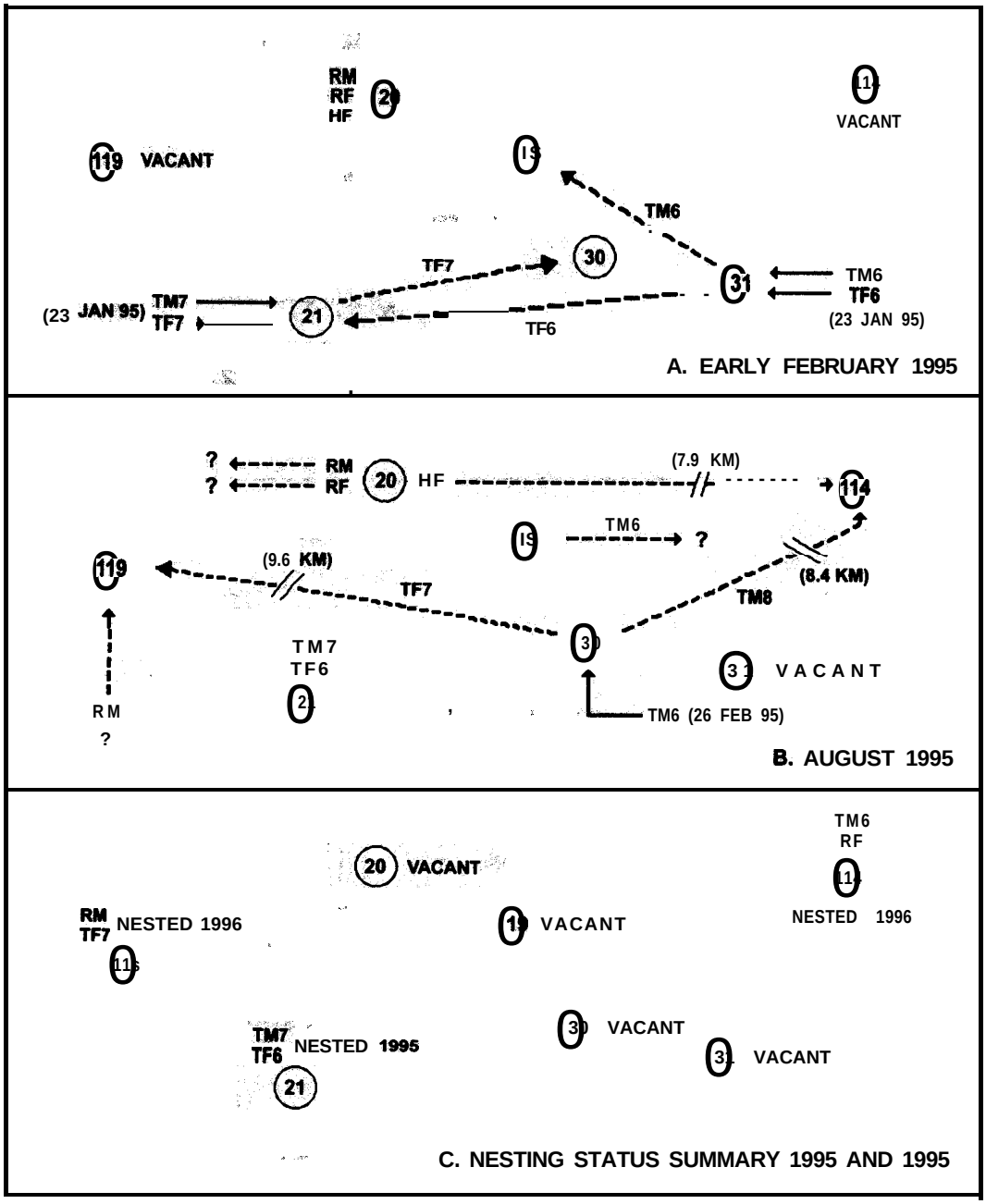


Fig. 2. Translocations and subsequent movements of red-cockaded woodpeckers in release area 2 on the Sabine National Forest, Texas (TM = translocated male; TF = translocated female; RM = resident male; RF = resident female; HF = helper female). Solid lines represent initial translocations, and dotted lines represent subsequent dispersal; Circles with numbers represent U.S. Forest Service compartment numbers, stand numbers, or cluster numbers. Question marks (?) represent unknown origins or destinations of red-cockaded woodpeckers.

A pair released in release area 3 separated and moved, but later paired elsewhere (see rectangle 3, Figs. 1, 3). One of the remaining 4 red-cockaded woodpeckers released in this area moved and paired with a resident female. Release of 6 red-cockaded woodpeckers combined with 1 resident woodpecker of unknown origin resulted in the formation of 2 breeding pairs in this area.

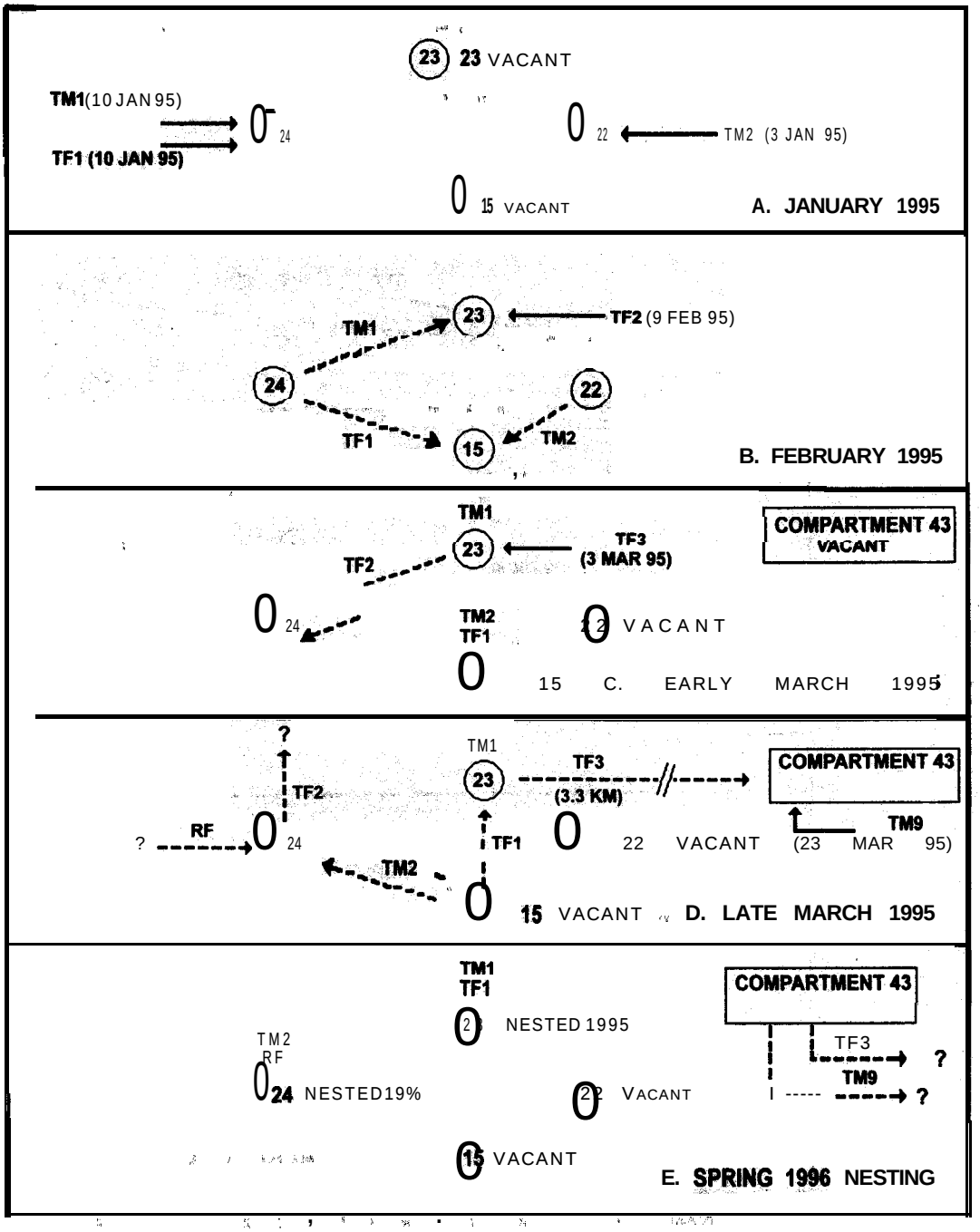
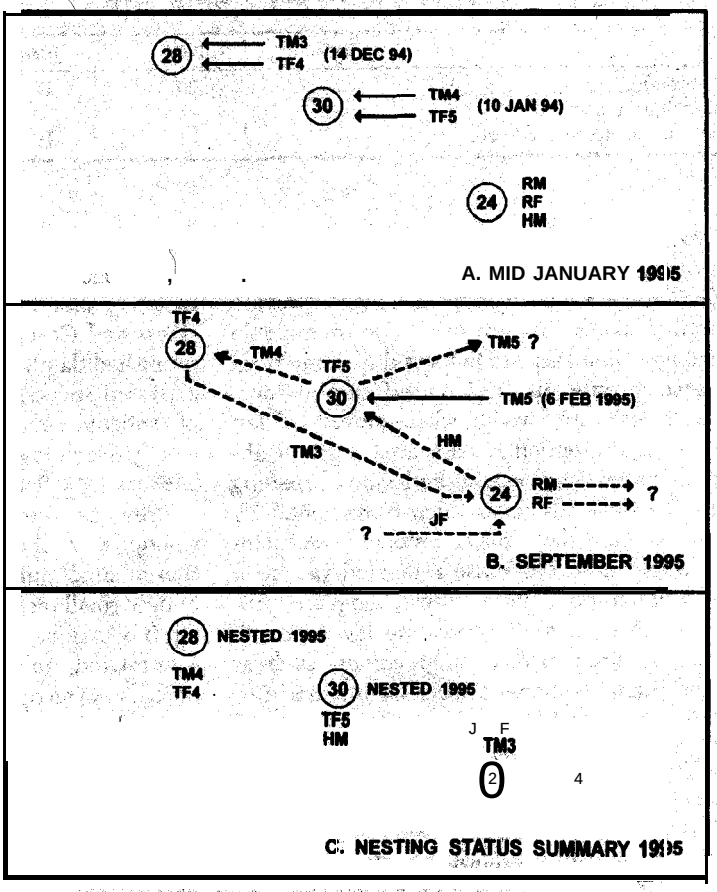


Fig. 3. Translocations and subsequent, movements of red-cockaded woodpeckers in release area 3 on the Sabine National Forest, Texas (TM = translocated male; TF = translocated female; RF = resident female). Solid lines represent initial translocations and dotted lines represent subsequent dispersal. Circles with numbers represent U.S. Forest Service compartment numbers, stand numbers, or cluster numbers. Question marks (?) represent unknown origins or destinations of red-cockaded woodpeckers.



Fii. 4. Translocations and subsequent movements of red-cockaded woodpeckers in release area 4 on the Sabine National . . Forest, Texas (TM = translocated male; TF = translocated female; RM = resident male; RF = resident female; HM = helper male; JF = subadult female). Solid lines represent initial translocations, and dotted lines represent subsequent dispersal. Circles with numbers represent U.S. Forest Service compartment numbers, stand numbers, or cluster numbers. Question marks (?) represent unknown origins or destinations of red-cockaded woodpeckers.

Both males from the 2 pairs released in release area 4 (see rectangle 4, Figs. 1, 4) moved, 1 of which paired with the female released in a nearby cluster. A resident' helper male paired, with the other female that remained in her release site. In this area, the release of 5 red-cock-. aded woodpeckers combined with 1 resident bird resulted in 3 occupied clusters (2 breeding) where 1 had previously occurred.

To summarize our results, reintroductions in the 4 areas' (rectangles 1–4, Fig. 1) resulted in an increase from 2 breeding groups and.1 single male to 9 breeding groups' by 1996. This increase resulted from the release of 17 red-cockaded woodpeckers plus 'the participation of 6 birds from the resident population and 3 birds of unknown origin. The 'total number of groups on the Sabine National Forest increased from , 13 to 21 between 1994 and 1995 and has since remained stable (Table 1).

DISCUSSION

Reintroduction of multiple pairs of red-cockaded woodpeckers, as suggested by Rudolph et al. (1992) and accomplished in this study, is an effective technique for reestablishing breeding units in formerly vacant habitat. Releasing several pairs in close proximity to each other and to resident groups provided the necessary social interaction for translocated individuals to settle in the area and obtainmates. The large number of pairs resulting from the combination of translocated and resident red-cockaded woodpeckers demonstrates the importance of releasing birds near existing groups. Under normal conditions, most subadult females disperse while subadult

Table 1. Numbers and breeding status of red-cockaded woodpecker groups on the Sabine National Forest, Texas, 1994-99.

	1994	1995	1996	1997	1998
No. breeding groups	12	20	19	20	19
No. solitary males	1	1	0	2	2
Total no. occupied territories	13	21	19	22	21

males may remain as helpers in their natal cluster or disperse (Walters et al. 1988). Translocated red-cockaded woodpeckers may provide potential mates that are otherwise unavailable to subadult females and helpers dispersing from isolated groups, in fragmented populations. Some translocated woodpeckers moved >5 km outside the intended release-area but still obtained mates and established new breeding units. In some instances, such translocated individuals may have filled breeding vacancies that would have otherwise remained vacant in the resident population. Few young are produced and immigration rates are low in small, demographically isolated populations, such as on the Sabine National Forest (Conner and Rudolph 1989, 1991). Consequently, such populations are particularly sensitive to 'losses of breeding adults (Conner and Rudolph 1989, 1991).

The level of success achieved on the Sabine National Forest is remarkable. By 1995, the translocation of 17 red-cockaded woodpeckers resulted in an increase from 3 groups to 10 in the release-areas, and from 2 breeding units to 9. By 1996, 8 groups remained in the release areas, 7 of which bred during 1996. These reintroductions increased the total number of groups on the Sabine National Forest from 13 to 19 in 18 'months; 'A 'minimum of 12 of the introduced red-cockaded woodpeckers was successfully incorporated into the recipient population. The fates of the remaining 5 individuals are unknown, but they are not necessarily dead or even lost-to the population. This rate of establishment into the breed&g population (71%) compares favorably with the annual survival of established red-cockaded woodpeckers (62–80% depending on social status) in a large, well-studied population in North Carolina (Walters et al. 1988).

The observed 71% establishment rate into the breeding population is above the expected success rate based on single translocations. The observed success rate of translocation of subadult female red-cockaded woodpeckers to resident adult males is approximately 60%, whereas the success rate for translocations of subadult males to resident adult females is about 40% (Hess and Costa 1995; N. R. Carrie et al., unpublished data). If operating independently, the expected success rate for simultaneous release of subadult male and female red-cockaded woodpeckers together might be predicted to be 24% ($0.60 \times 0.40. = 0.24$).

Previous reintroductions of red-cockaded woodpeckers that have involved the translocation of small numbers of woodpeckers resulted in only small increases in the overall population. On 3 occasions, Allen et al. (1993) translocated 2 unrelated, unknown-age red-cockaded woodpeckers of the opposite sex to an inactive cluster within the Savannah River Site in Georgia in an effort to start a new group. None of the 3 pairs bred, although 1 male and 1 female later successfully bred with different mates. Rudolph et al. (1992) moved a subadult female and a helper male red-cockaded woodpecker to an inactive cluster. The male returned to his original cluster. A secondsubadult male translocated to the site eventually paired and successfully bred with the female. A second pair of unrelated subadult red-cockaded woodpeckers introduced by Rudolph et al. (1992) on the Sabine National Forest in February 1992 remained at the release site into April 1992. We suggest reintroduction efforts would be most effective in small declining populations if continued for several years and ≥4 pairs of subadult red-cockaded woodpeckers are translocated within a reintroduction period., Sufficient numbers of breeding units might become established, during this time that natural dispersal of subadult birds originating from these new groups could effectively fill breeding vacancies occurring in the population. Short-term reintroduction programs that last ≤2 years may not establish enough new breeding units in the recipient population, to offset population declines.

This level of success is dependent on careful preparation. We chose sites where midstory conditions were good, adequate cavities were

available, and introduced red-cockaded! woodpeckers had options in terms of available mates and clusters within a small 'geographic radius. Anecdotal observations on other introductions suggest monitoring immediately after the release should* be minimal. Immediately after release, the birds are likely stressed and have had recent bad experiences with humans. In this situation, they may be more sensitive to even minor human disturbances than normal. In any case, immediate and 'repeated monitoring of released birds serves no useful purpose, because follow-up releases normally do not, and should not; take place for 'several weeks.

The considerable movementwe observed between the release sites and surrounding sites suggests the availability and distribution of suitable cavities in surrounding sites (recruitment stands, abandoned clusters, or both) is an important factor contributing to successful establishment of pairs in vacant 'habitat. Typically, red-cockaded woodpeckers disperse following release and may move through the area for an extended period. Availability of suitable cavities in stands around the release site provides temporary roost sites and may induce woodpeckers to remain in the area. Such sites also provide additional sites for pairs to become established. We suggest inserts installed in such sites should be highly visible, with large amounts of either synthetic wood filler or white paint to simulate the resin wells normally made by the red-cockaded woodpeckers. Although no information is available on the relation between insert visibility and occupation rates by red-cockaded woodpeckers, inserts with large numbers of simulated resin wells appear to be occupied more frequently than inserts lacking the simulated resin barrier (N. R. Carrie, personal observation). In addition, to increase habitat quality and enhance visibility of artificial cavities, midstory control should be accomplished in release sites and all surrounding sites prior to translocations (Loeb et al, 1992).

MANAGEMENT IMPLICATIONS

Our views concerning reintroduction of red-cockaded woodpeckers have evolved considerably since our initial concern with the issue in the late 1980s. Prior to our reintroduction of the first 2 pairs in 1991-92 (Rudolph et al. 1992), we had considered building a temporary aviary to restrain red-cockaded woodpeckers in the cluster area and to allow development of ties, to the site. We sought funding for such a scheme but eventually opted for direct reintroduction. Our success. on a limited scale (Rudolph et al. 1992) and the success on an operational scale reported in this paper demonstrate that direct reintroduction is feasible. Successful reintroductions appear to depend less on establishing ties between red-cockaded woodpeckers and specific sites and more on adding birds to populations in demographically isolated areas, and adequately preparing such areas for reintroductions. The measures of success reported in this study, compared to the fates of resident red-cockaded woodpeckers reported by Walters et al: (1988), suggest little is to be gained through the more elaborate and expensive procedures involving a temporary or mobile aviary.

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