Trans. Ky. Acad. Sci., 56(3–4), 1995, 109–113

Foraging of Red-cockaded Woodpeckers (*Picoides borealis*) in Kentucky

Martina Hines[1] and Paul J. Kalisz

Department of Forestry, University of Kentucky,
Lexington, KY 40546-0073

Abstract

The 5 groups of red-cockaded woodpeckers (*Picoides borealis*) remaining on the Daniel Boone National Forest in 1990–1991 were observed during the winter and nesting seasons to determine the importance of different tree species as foraging substrates. On the average, red-cockaded woodpeckers foraged on hardwoods 14% of the time during the winter and 44% of the time during the nesting season. During the winter season, birds in 3 groups exhibited statistically significant preferences for foraging on pines compared to hardwoods ($P < 0.001$), and birds in 2 groups exhibited no preferences. During the nesting season, birds in 2 groups preferred hardwoods ($P < 0.004$), birds in 1 group preferred pine ($P < 0.003$), and birds in 2 groups exhibited no preferences. Southern red oak (*Quercus falcata*), black oak (*Q. velutina*), and white oak (*Q. alba*) were the hardwood species used most frequently by foraging red-cockaded woodpeckers. Our results suggest that management based primarily on the removal of hardwoods to improve red-cockaded woodpecker habitat contributes to loss of biodiversity and may ultimately lead to the extirpation of the local population of the species.

Introduction

The northern-most population of the endangered red-cockaded woodpecker (*Picoides borealis*) occurs on the Daniel Boone National Forest in southeastern Kentucky. As of November, 1994, only 4 or 5 birds in 2 groups survived. The range of this population is disjunct from others to the south, with little possibility of gene flow into Kentucky. The habitat is mixed pine-oak forests with well-developed lower canopy strata (1), vegetation typical for dry sites in the Appalachians but atypical for red-cockaded woodpecker habitat.

Management of this declining red-cockaded population by the U.S. Forest Service is based on the assumption, developed in the pine forests of the southeastern Coastal Plain, that habitat quality for red-cockaded woodpeckers is reduced in proportion to the occurrence of hardwoods in a stand (e.g., 2). This implies that red-cockadeds prefer pines and discriminate against hardwoods as a foraging substrate. To date, this assumption has not been tested in hardwood-dominated regions such as Kentucky. The objective of this study was to determine if red-cockaded woodpeckers in Kentucky exhibit a preference for pines as a foraging substrate. This is an important question because recent management by the Forest Service has been largely based on this belief, and has relied on cutting and prescribed burning to remove hardwoods from active and inactive red-cockaded colony sites and other areas judged potentially suitable as colony sites for the species (3).

Materials and Methods

Study Area.—The study area was located in Laurel and Whitley Counties on the Daniel Boone National Forest in southeastern Kentucky (36°48′N, 84°18′W). This area lies along the escarpment defining the western edge of the Cumberland Plateau physiographic region and is included in the Mixed Mesophytic Forest region (1).

The topographic heterogeneity of the landscape explains the presence of numerous forest types. Ridge tops are predominantly covered with pine and mixed pine-hardwood stands. These stands are often small and occur as narrow bands along elevational contours. Common species include shortleaf pine (*Pinus echinata*), white oak (*Quercus alba*), various red oak species, and hickory (*Carya* spp.). The mid- and understories present throughout the study area are composed of red maple (*Acer rubrum*), sourwood (*Oxydendrum aboreum*), blackgum (*Nyssa sylvatica*), and dogwood (*Cornus florida*) (1). The lower slopes are

[1] Present address: Kentucky Nature Preserves Commission, 801 Schenkel Lane, Frankfort, KY 40601.

dominated by hardwood stands and contain a low percentage of pines. Typical species are chestnut oak (*Quercus prinus*), red and white oaks, yellow poplar (*Liriodendron tulipifera*) and beech (*Fagus grandifolia*). On northerly slopes and in ravines, characteristic species include hemlock (*Tsuga canadensis*) and rhododendron (*Rhododendron maximum*). Hardwood stands occupy approximately 65% of the area, and pine and pine-oak stands, which are considered suitable habitat for red-cockaded woodpeckers, account for the remaining 35% of the forested area (1).

Field Methods.—Birds were observed at the 5 active colony sites from October to June, 1990–1991, and from December to March, 1991–1992. Four of the sites were occupied by pairs of birds, and the other site was occupied by a single bird. Data were systematically collected only during the 1991–1992 observation period to statistically describe foraging during the winter (December to March) and nesting seasons (April to June). During the winter period, foraging data were collected during 31 field sessions, 18 during the morning (2-hour period following sunrise) and 13 during evening (2-hour period preceding sunset). A total of 311 minutes of observation was collected. During the nesting period foraging data were collected during 19 field sessions, 14 during midday, 3 during the morning and 2 during the evening. A total of 426 minutes of observation was collected.

All foraging data were collected when the birds were near their cavity trees since cliffs, cut trees and brush prevented us from following the birds. During the nesting season, red-cockaded woodpeckers could be observed for relatively long periods because they spent much of their time close to the nest tree when feeding young. Birds were observed in areas that were approximately circular around cavity trees and ranged from 2.4 to 4.1 ha.

When recording data, we assumed that a red-cockaded woodpecker was foraging when it probed, picked or flaked bark as described by Hooper and Lennartz (4). Birds were not considered to be foraging when active on the cavity tree around the cavity entrance or resin wells. Observations were made at 1-minute intervals to record the species of tree on which the bird was foraging. Observations collected in this way may be considered independent for the purpose of testing the foraging preferences of individual birds (M. Lacki, pers. comm.). Since the birds were not banded it was impossible to distinguish between individuals in groups composed of 2 birds, and, therefore, for statistical analyses, data recorded for groups were treated as if they were recorded for an individual bird.

TABLE 1. Importance (expressed as percentage of basal area and density) of tree species in red-cockaded woodpecker colonies.

	Percentage			
	Basal area (stems ≥10 cm DBH)		Density (stems ≥2 & <10 cm DBH)	
Species	Mean	Median	Mean	Median
Pinus echinata	55	57	0	0
Quercus coccinea	10	6	1	2
Carya spp.	7	6	7	8
Quercus alba	6	4	0	1
Quercus velutina	4	2	2	4
Pinus virginiana	4	8	0	0
Pinus rigida	0	1	0	0
Quercus stellata	3	3	1	1
Quercus falcata	2	1	5	6
Quercus prinus	2	2	1	1
Acer rubrum	2	2	24	21
Liriodendron tulipifera	1	2	8	17
Cornus florida	1	2	21	26
Nyssa sylvatica	1	2	2	2
Tsuga canadensis	1	2	6	11
Oxydendrum arboreum	1	1	12	13
Magnolia sp.	0	0	5	11
Amelanchier arborea	0	0	0	9
Carpinus caroliniana	0	0	2	4
Sassafras albidum	0	0	2	4
Fagus grandifolia	0	0	1	2

At each colony site, the vegetation within the area used for foraging was described. At each site, circular 0.05-ha plots were randomly located at a density of 5 per ha, and the diameter at a height of 1.4 m (DBH) and species of every tree ≥10 cm DBH was recorded. Within a 4 × 25 m strip across each circle, the number and species of stems <10 cm DBH and ≥2 cm DBH were recorded (Table 1).

Statistical Analysis.—Chi-square tests were used to determine whether or not woodpeckers preferred pines or hardwoods as foraging substrate. The availability of pines and hardwoods was expressed as the percentage of the total basal area; for each site this percentage was used to calculate the expected number of foraging observations from the total number of observations. Expected values calculated in

this way represented the case where red-cockadeds did not discriminate between pines and hardwoods, but foraged in the two types of trees in proportion to their occurrence.

Since the total population consisted of only 9 birds, and these were divided into 5 groups with members that were indistinguishable, it was impossible to collect enough independent observations to make statistical statements regarding the foraging preferences of the entire red-cockaded population on the Daniel Boone National Forest. Statistical analyses were therefore only performed for the individual groups of birds at each site, and observations pertaining to the entire population were summarized, but not analyzed, statistically. The numbers of observed and expected foraging observations on both pines and hardwoods were used to calculate chi-square values for each colony site to test for preference for either tree type. Winter and nesting season data were analyzed separately.

RESULTS

Basal areas of stems ≥10 cm DBH ranged from 5 m^2/ha to 13.3 m^2/ha, with an average of 12 m^2/ha. Pine accounted for 48 to 74% of the basal area. Shortleaf pine was the most important species in red-cockaded woodpecker colonies accounting for 55% of the total basal area with a range of 40 to 70% (Table 1). In contrast, pitch pine (*Pinus rigida*) and Virginia pine (*P. virginiana*), respectively, accounted for <1 and 4% of the basal area. Six species of oaks accounted for 27% of the total basal area and 68% of the non-pine basal area. Other individual hardwood species accounted for <2% of the basal area (Table 1). For stems <10 cm and ≥2 cm DBH, total stem density ranged from 90 to 650 stems/ha over all 5 colony sites. In contrast with conditions on the study area (Table 1), Forest Service recommendations for optimum red-cockaded habitat specify that hardwood density per acre should be <10/ac in the upper canopy level and <3/ac in the mid-story (3).

During both winter and nesting seasons, red-cockaded woodpeckers spent more time on shortleaf pine (74% in winter; 50% in nesting season) than on any other tree species. The hardwoods used by red-cockaded woodpeckers were scarlet oak (*Quercus coccinea*), white oak, southern red oak (*Q. falcata*), post oak (*Q. stellata*), black oak (*Q. velutina*) and hickory. Red-cockaded woodpeckers were sometimes seen foraging on red maple during the winter, and on sourwood, chestnut oak and, rarely, dogwood during the nesting season. Red-cockaded woodpeckers were never observed on yellow poplar, black gum, or eastern hemlock.

TABLE 2. Levels of significance (*P*) for individual colonies of tests of red-cockaded woodpeckers' preference for pines or hardwoods (Hdwd) as foraging substrate during the winter and nesting seasons.

Colony	Nesting Season		Winter Season	
	P	Preference	*P*	Preference
I	0.19	None	<0.001	Pine
II	0.003	Pine	0.096	None
III	0.004	Hdwd	>0.250	None
IV	<0.001	Hdwd	<0.001	Pine
V	>0.250	None	<0.001	Pine

During the winter, 311 (86%) foraging observations were on pines and 52 (14%) on hardwoods. Statistical analyses of the individual colonies showed that red-cockadeds preferred pine over hardwoods at 3 colonies but did not exhibit a preference at the other two colonies (Table 2).

During the nesting season, 239 (56%) foraging observations were on pines and 187 (44%) were on hardwoods. Among the 5 colonies, foraging ranged from 34 to 89% on pines, and from 11 to 66% on hardwoods. During the nesting season the birds statistically preferred pine at one colony, hardwoods at 2 colonies, and showed no preference at 2 colonies (Table 2).

During the winter red-cockaded woodpeckers showed no apparent preference for any individual hardwood species as foraging substrate. During the nesting season, however, red-cockaded woodpeckers, on average, utilized the southern red oak/black oak and the white oak/post oak (*Q. stellata*) groups far above their proportional occurrence in the stands. Conversely, during the nesting season, red-cockaded woodpeckers seldom foraged on scarlet oak and hickory, although these taxa were among the most important hardwoods on all sites.

DISCUSSION

Red-cockaded woodpeckers in our study area spent most of their time foraging on pine

trees, and statistically preferred pines on 3 sites during the winter season (Table 2). This result was consistent with past research (4, 5, 6, 7, 8). From previous reports of red-cockadeds foraging on hardwoods (4, 6, 9, 10), the highest reported use was in Mississippi where birds spent 22% of their time on hardwoods (6). Our finding that during the nesting season, on average, red-cockaded woodpeckers foraged on hardwoods 44% of the time, and statistically preferred hardwoods on 2 sites, contradicts the results of research in more typical habitat where red-cockaded woodpeckers seem to always prefer pines over hardwoods (4).

Our results support previous reports (4, 9) that red-cockaded woodpeckers exhibit a seasonal change in foraging preference for pines and hardwoods (Table 2). The seasonal change in preference that we documented may have been due to a shortage of arthropods on bole surfaces during the winter (11). This would force red-cockaded woodpeckers to concentrate their winter foraging on the thick, flaky bark of pines which offers protective habitat for a large number of over-wintering arthropods (12). In contrast to other woodpeckers, red-cockaded woodpeckers forage chiefly by scaling and flaking bark rather than by excavating holes (4, 8). Flaking is especially critical during winter when most prey are hidden beneath bark. During the nesting season, arthropods are probably more abundant on bole surfaces, allowing red-cockaded woodpeckers to forage on both pine and hardwood species.

The foraging behavior of red-cockaded woodpeckers in the pine-hardwood forests of the Daniel Boone National Forest is clearly different from that of red-cockadeds living in pure pine forests further south. The birds in Kentucky seem to readily use hardwoods as a foraging substrate, especially during the warmer parts of the year. This result supports prior assertions (13, 14) that red-cockaded woodpeckers are opportunistic foragers that take advantage of a wide array of food sources, and demonstrates adaptation of the local population to the foraging habitat typical of the Appalachians.

Our results have important implications for management of red-cockaded woodpeckers on the Daniel Boone National Forest, especially since the results of this one-year study were in agreement with our previous observations of foraging behavior on the study area. Present management is based on regional guidelines that in turn are based primarily on research in other, ecologically very different, parts of the red-cockaded woodpecker's range. Specific recommendations are to remove hardwoods from both the upper and lower canopy strata within areas ≥4 ha surrounding all active and abandoned cavity trees, and in areas designated as recruitment and replacement stands; prescribed fire at 2–5 year intervals is recommended to control sprouts from the stumps of the cut hardwoods (3). Implementation of these recommendations will make the species-rich and structurally-diverse forests of the area more uniform and less complex. Such management contrasts with the national trend towards preserving and restoring natural patterns of biodiversity, and with the regional tendency towards hardwood dominance. In particular, the drastic habitat alteration caused by the removal of hardwoods may cause the local population to become maladapted to its habitat, and may contribute to a loss of genetic diversity and ultimately to the extirpation of red-cockaded woodpeckers in Kentucky.

ACKNOWLEDGMENTS

This work was supported by McIntire-Stennis funds and by the Daniel Boone National Forest. This is a contribution of the Kentucky Agricultural Experiment Station, Paper no. 95-09-013.

LITERATURE CITED

1. Kalisz, P. J. and S. E. Boettcher. 1991. Active and abandoned red-cockaded woodpecker habitat in Kentucky. J. Wildl. Manage. 55:146–154.

2. Hooper, R. G., A. F. Robinson, Jr., and J. A. Jackson. 1980. The red-cockaded woodpecker: notes on life history and management. U.S. For. Serv. Gen. Rep. SA-GR 9.

3. U.S. Forest Service. 1993. Draft environmental impact statement for the management of the red-cockaded woodpecker and its habitat on national forests in the Southern Region. Forest Service, Southern Region, Atlanta, Georgia.

4. Hooper, R. G. and R. M. Lennartz. 1981. Foraging behavior of the red-cockaded woodpecker in South Carolina. Auk 98:321–334.

5. Morse, D. H. 1972. Habitat utilization of the red-cockaded woodpecker during winter. Auk 89:429–435.

6. Ramey, P. 1980. Seasonal, sexual, and geographic variation in the foraging behavior of red-cockaded wood-

pecker (*Picoides borealis*). M.S. Thesis. Mississippi State University.

7. DeLottele, R. S. and J. R. Newman. 1971. Habitat use of red-cockaded woodpeckers in central Florida. Pp. 56–67. In R. L. Thompson (ed.) The ecology and management of the red-cockaded woodpecker. U.S. Dept. of Interior, Bureau of Sport Fisheries and Wildlife, and Tall Timbers Research Stn., Tallahassee, Florida.

8. Repasky, R. R. and P. D. Doerr. 1991. Home range and substrate use by two family groups of red-cockaded woodpeckers in the North Carolina Sandhills. Brimleyana 17:37–52.

9. Skorupa, J. P. and R. W. McFarlane. 1976. Seasonal variation in foraging territory of red-cockaded woodpeckers. Wilson Bull. 88:662–665.

10. Wood, D. A. 1983. Foraging and colony habitat characteristics of the red-cockaded woodpecker in Oklahoma. Pp. 51–58. In D. A. Wood (ed.) Red-cockaded woodpecker symposium II. Fla. Game and Fresh Water Fish Comm., Tallahassee.

11. Conner, R. N. 1979. Seasonal changes in woodpecker foraging methods: Strategies for winter survival. Pp. 95–105. In R. N. Conner, J. G. Dickson, R. R. Fleet, J. A. Jackson, and J. C. Kroll (eds.) The role of insectivorous birds in forest ecosystems. Academic Press, London.

12. Travis, J. 1977. Seasonal foraging in the downy woodpecker population. Condor 79:371–375.

13. Beal, F. 1911. The food of the woodpeckers of the United States. USDA Biol. Surv. Bull. No. 37.

14. Baker, W. W. 1971. Observations on the food habits of the red-cockaded woodpecker. Pp. 100–105. In R. L. Thompson (ed.) The ecology and management of the red-cockaded woodpecker. U.S. Dept. of Interior, Bureau of Sport Fisheries and Wildlife, and Tall Timbers Research Stn., Tallahassee, Florida.