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Hurricane Damage to Red-cockaded Woodpecker (*Picoides borealis*) Cavity Trees

R. TODD ENGSTROM¹ AND GREGORY W. EVANS²

Department of Biological Science, Florida State University,
Tallahassee, Florida 32306 USA

The Red-cockaded Woodpecker (*Picoides borealis*) is a federally endangered species, which inhabits pine forests in the southeastern United States (Ligon 1970). Red-cockaded Woodpeckers excavate cavities for roosting and nesting in mature, living pine trees (Baker 1971), preferably longleaf pine (*Pinus palustris*) infected by redheart disease (*Fomes pini*) (Lennartz et al. 1983). Excavation of a single cavity may require a year or more, and it has been suggested that cavity trees are the primary ecological constraint that shaped the evolution of the cooperative breeding system of the Red-cockaded Woodpecker (Lennartz et al. 1987, Walters et al. 1988).

Natural disturbance is an important component of the southeastern pine forests inhabited by the Red-cockaded Woodpecker (Christensen 1977). Frequent surface fires maintain the open habitat favored by Red-cockaded Woodpeckers (Ligon et al. 1986). High winds and lightning associated with frequent summer thunderstorms and, less frequently, tornadoes and hurricanes are important sources of mortality among larger pines (Platt et al. 1988). In late summer and autumn 1985, three major storms struck the northeastern Gulf of Mexico: tropical storm Juan, and hurricanes Elena and Kate. The combination of heavy rain that saturated the soil and strong winds damaged some forests in northern Florida and southern Georgia. Trees were blown over and tree trunks snapped. During hurricane Kate, downbursts of wind gusting to 160 km per hour were estimated for Leon County, Florida (Clark 1986). We report the damage caused by these storms (mostly hurricane Kate) to Red-cockaded Woodpecker cavity trees in an old-growth longleaf pine forest in southern Georgia.

The Wade Tract, an 80-ha conservation easement managed by Tall Timbers Research Station in south-

ern Thomas County, Georgia, contains one of the largest remaining old-growth longleaf pine populations. As part of a long-term study of life history dynamics (Platt et al. 1988), all pines taller than breast height (1.5 m) on a 46-ha section of the Wade Tract were given identification numbers on metal tags in 1979. The diameter at breast height (DBH) of all tagged trees was recorded in 1979, and the surviving tagged trees were remeasured in 1984. Tagged trees were censused annually for mortality through 1987.

Red-cockaded Woodpeckers are common in the Wade Tract (Engstrom 1982). Some Red-cockaded Woodpecker nest trees were identified in 1979, but no systematic inventory of cavity trees was done before the storms in autumn 1985. In the spring of 1986, Engstrom visually inspected trees in the Wade Tract during a study of hurricane damage to the entire forest. All Red-cockaded Woodpecker cavity trees in the 46-ha study site were located at this time. Among nearly 7,800 marked and measured trees that were standing before the storms in the autumn of 1985, 33 were Red-cockaded Woodpecker cavity trees. These cavity trees ranged in size from 30 to 69.2 cm DBH (\bar{x} = 49.0 cm; Fig. 1).

Of 33 Red-cockaded Woodpecker cavity trees, 8 (24%) were killed during autumn 1985 (4 during hurricane Kate). Trunks of six of the eight trees snapped off at the site of the woodpecker cavity; trunks of the remaining two trees snapped below the cavity. Five of the eight Red-cockaded Woodpecker cavity trees that were snapped off had rotten heartwood most likely caused by redheart disease. The remaining three trees did not have obviously rotten heartwood at the point of the snapped trunk. Four additional cavity trees suffered a loss of large limbs or a gash in the trunk that may increase the chance of mortality over the next decade.

On the Wade Tract, age (measured with increment cores) and size (DBH) of 399 randomly selected longleaf pine trees are highly correlated (Platt et al. 1988). Trees of approximately 30 cm DBH in this random sample ranged from just under 40 to over 80 years old, and trees with diameters of approximately 60 cm DBH ranged from roughly 180 to 240 years old. Al-

¹ Present address: Tall Timbers Research Station, Route 1, Box 678, Tallahassee, Florida 32312 USA.

² Present address: Department of Public Health Sciences, The Bowman Gray School of Medicine, Wake Forest University, 300 South Hawthorne Road, Winston-Salem, North Carolina 27103 USA.

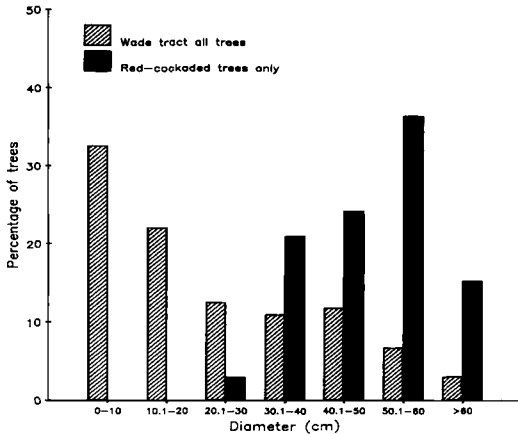


Fig. 1. Available trees ($n = 7,766$) and trees used by Red-cockaded Woodpeckers for cavities ($n = 33$) on the Wade Tract.

though the relationship between size and age of long-leaf pine trees has a large variance among trees older than 80 years, Red-cockaded Woodpeckers clearly selected larger (thus older) trees for cavity sites on the Wade Tract (Fig. 1). Contrary to the conclusions drawn by Field and Williams (1985) from a literature review, we found that Red-cockaded Woodpeckers prefer older trees for cavities, in agreement with other studies (Jackson et al. 1979, Jackson and Jackson 1986, DeLotelle and Epting 1988).

Trees in the size classes from 30 to 70 cm DBH (the classes used by Red-cockaded Woodpeckers on the Wade Tract) are a fairly stable resource in nonhurricane years. Only 2.7% of all trees in these size classes died during the 4-yr period from 1980 to 1983 (Platt et al. 1988). We cannot directly estimate the probability of mortality among cavity trees during years without hurricanes, because cavity trees had not been systematically identified before 1985. Nevertheless, the 25% mortality of cavity trees during autumn 1985 appears to be at least an order of magnitude greater than the mortality expected to occur during the same interval in nonhurricane years.

Even though not all cavity trees of the Red-cockaded Woodpecker were used actively by birds in 1985, the abrupt elimination of available cavities may adversely affect survival of the species. Many animals other than Red-cockaded Woodpeckers use Red-cockaded Woodpecker cavities (Harlow and Lennartz 1983). Competition from other animals for cavities for roosting and nesting could increase as a result of the shortage of available cavities caused by hurricane damage. Red-cockaded Woodpeckers that are forced to roost out of cavities may be more likely to die from increased exposure to inclement weather or predation. The loss of nearly one quarter of the Red-cockaded Woodpecker cavity trees on the Wade Tract within a

few months represents a rare but severe reduction of a normally stable resource for this endangered species. Because several years may be required for the species to replace the cavities that were lost, long-term effects of the 1985 storms on the Wade Tract Red-cockaded Woodpecker population are currently unknown.

Damage to mature pine trees used by Red-cockaded Woodpeckers for nesting and roosting on the Wade Tract could be classified as a severe disturbance. The degree of destruction on the Wade Tract may be minor compared with the extensive damage caused by hurricane Hugo to the Francis Marion National Forest in September 1989. Management and recovery plans for endangered species such as the Red-cockaded Woodpecker must include the possible effects of infrequent disturbances or catastrophes such as hurricanes.

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Geographic Variation in the Juvenal Plumage of the Common Nighthawk (*Chordeiles minor*) in North America

ROBERT W. DICKERMAN

Department of Ornithology, American Museum of Natural History, Central Park West at 79th Street,
New York, New York 10024 USA

Few studies of geographic variation have included discussion of variation in the juvenal plumage. Such variation may or may not parallel that in the definitive basic or alternate plumages usually studied. Indeed, the juvenal plumage may have characters of its own (e.g. *Icterus prothemelas praecox*, Phillips and Dickerman 1965). Specimens of juveniles taken just before—or shortly after—fledging, when the plumage is fresh, unworn, and unfaded, are scarce for many species of birds. Therefore such studies, based on whatever material can be assembled, should be of intrinsic interest.

This review of geographic variation in the juvenal plumage of the Common Nighthawk (*Chordeiles minor*) was stimulated by two small nestlings in the collection of the American Museum of Natural History (AMNH) collected along the Cheyenne River, Custer County, South Dakota, 10 and 14 July 1894, by Walter Willis Granger. The older chick is sufficiently feathered to make comparisons of pattern and color. The label bears the notations "*minor?*" and "*minor* or *acutipennis*." I originally considered it to be *C. acutipennis*, and had included both in a study of the juvenal plumage of that species (Dickerman 1981). Subsequently, at the suggestion of Allan R. Phillips, I sought other specimens of nestlings of *C. m. sennetti* for comparison. At that time only two other preflight young of *sennetti* were found among the collections of North America (another was later found in the AMNH collection, labeled "*virginianus* HCO" [see below] in a tray with specimens of uncertain localities!). The juvenal plumage of the young *sennetti* was pale and matched that of the Cheyenne River specimen. Dur-

ing the course of this exercise, I realized that there was considerable variation among juveniles of the species, and I sought additional specimens.

Study of juvenal plumages in this species is complicated by the extent of dispersal of birds while still in this plumage (Laybourne and Post pers. comm.). In so far as possible, therefore, only preflight young—or fledged young that agree well in color characters with preflight young from well within the range of any subspecies—were used for plumage descriptions.

Oberholser (1914) in his revision of *Chordeiles minor* (then called *C. virginianus*) occasionally mentioned the juvenal plumage, but it is often unclear whether he meant the natal, juvenal, or even first basic plumages (cf. nestling descriptions under *sennetti*, p. 53).

Selander (1954) mentioned preflight young in his account of *henryi*, and also recognized the juvenal plumage as important in mapping the nesting ranges of subspecies. He specifically cited two tawny-backed, partially grown "immatures" (i.e. preflight juveniles) from Mesa County in west-central (not "southwestern") Colorado as northern specimens of *henryi*. However, he cited fledged juveniles in his discussion of the distribution of western subspecies, although birds in juvenal plumage may wander far from their hatching site.

Oberholser (1914: pl. 3) presented a map of the nesting ranges of the North American subspecies. Selander (1954: 68) modified the ranges in the western Great Plains and Rocky Mountain regions. I refined the ranges of several subspecies further by the identification of preflight young.

I studied a total of 75 juveniles (some already