BENT, A. C. 1958. Life histories of North American blackbirds, orioles, tanagers, and their allies. U.S. Nat. Mus. Bull. No. 211.

BERTIN, R. I. 1982. The Ruby-throated Hummingbird and its major food plants, ranges, flowering phenology and migration. Can. J. Zool. 60:210–219.

BROUN, M. 1939. Fall migration of hawks at Hawk Mountain, Pennsylvania 1934–1938. Auk 58:429–441.

CALDER, W. A., III. 1974. Consequences of body size for avian energetics. Pp. 86–151 *in* Avian energetics (R. A. Paynter, Jr., ed.). Publ. Nuttal Ornith. Club No. 15.

GRANT, K. A. AND V. GRANT. 1967. Effects of hummingbird migration on plant speciation in the California flora. Evolution 21:457–465.

HALL, G. A. AND R. K. BELL. 1981. The diurnal migration of passerines along an Appalachian ridge. Am. Birds 35:135–138.

HEINTZELMAN, D. S. AND R. MACCLAY. 1972. An exceptional Ruby-throated Hummingbird migration. Cassinia No. 53, p. 45.

JOHNSGARD, P. 1983. The hummingbirds of North America. Smithsonian Institution Press, Washington, D.C.

NORRIS, R. A., C. E. CONNELL, AND D. W. JOHNSTON. 1957. Notes on fall plumages, weights, and fat condition in the Ruby-throated Hummingbird. Wilson Bull. 69:155–163.

OBERHOLSER, H. C. 1924. The migration of North American birds: XXIV. Ruby-throated, Black-chinned, and Calliope hummingbirds. Bird Lore Mar–Apr:108–111.

ORTIZ-CRESPO, F. I. 1972. A new method to separate immature and adult hummingbirds. Auk 89:851–857.

PHILLIPS, A. R. 1975. The migrations of Allen's and other hummingbirds. Condor 77: 196–205.

POOLE, E. L. 1964. Pennsylvania birds, an annotated list. Livingston Publishing Company, Narbeth, Pennsylvania.

SCHNEIDER, D. AND B. HARRINGTON. 1981. Timing of shorebird migration in relation to prey depletion. Auk 98:801–811.

SOKAL, R. AND J. ROHLF. 1981. Biometry. Freeman, New York, New York.

SPRUNT, A., JR. AND E. B. CHAMBERLAIN. 1949. South Carolina Bird Life. Univ. South Carolina Press, Columbia, South Carolina.

LORI A. WILLIMONT, STANLEY E. SENNER, AND LAURIE J. GOODRICH, *Hawk Mountain Sanctuary Association, Rte. 2, Kempton, Pennsylvania 19529.* (Present address LAW: *Dept. Biological Sciences, Mississippi State Univ., Mississippi State, Mississippi 39762-5759.)* *Received 18 Aug. 1987, accepted 15 Feb. 1988.*

Wilson Bull., 100(3), 1988, pp. 488–494

Fulvous Whistling-Duck abundance and habitat use in southwestern Louisiana.—The Fulvous Whistling-Duck (*Dendrocygna bicolor*) is a locally common breeding bird of the rice (*Oryza sativa*) belt of southwestern Louisiana, which had nesting densities of 13–20 pairs within a 12.95-km^2 area in the mid-1950s (Meanley and Meanley 1959). This species declined rapidly in the 1960s, apparently from exposure to pesticides applied to rice (Flickinger and King 1972). The population increased in the 1970s with the discontinued use of aldrin-treated rice seed and the conversion from aerial seeding to drill planting, and by late

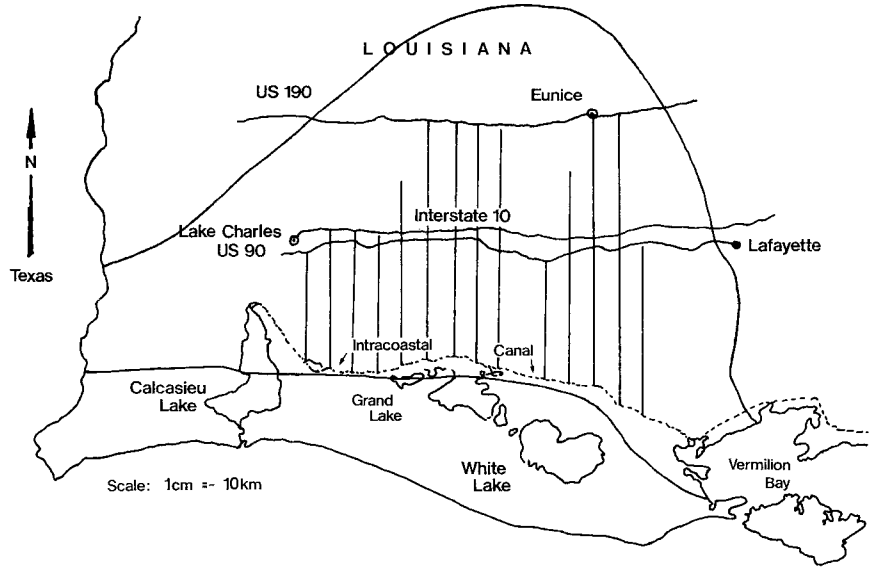

FIG. 1. Transects used for aerial surveys of Fulvous Whistling-Ducks within rice belt as delineated by Meanley and Meanley (1959).

summer 1975, there were an estimated 10,000 Fulvous Whistling-Ducks in Louisiana (Flickinger et al. 1977). The present paper provides estimates of Fulvous Whistling-Duck abundance and habitat use in the rice belt of southwestern Louisiana during 1984–1985.

Monthly aerial surveys were conducted to estimate Fulvous Whistling-Duck abundance and habitat use. This species was observed on transects only during April–August surveys, so only those five monthly surveys were included in analyses. Surveys consisted of 14 transects equally spaced at 3.75-min intervals (Fig. 1). Transects extended from longitude 93°10.00'W to 92°17.71'W. The Intracoastal Waterway was the southern terminus for all lines. The northern terminus varied among lines; some lines ended at US 190; others were terminated when large contiguous areas of woods, residences, or soybean (*Glycine max*) fields were encountered (Fig. 1). The total length of each survey was about 1300 km. Surveys were conducted from a Partenavia twin-engine aircraft (use of brand names does not imply endorsement by the U.S. Government) flown at approximately 165 km/h. The plane was modified to include a transect-width-estimation harness under each wing (Norton-Griffiths 1978). Harness markers corresponded to an approximate 250-m transect width at 46-m flight altitude. A computerized LORAN-C directional system was used to locate starting and ending coordinates and keep the plane on course. The first transect of each survey was alternated between the most westerly and the most easterly, with the beginning point always on the southern terminus. Surveys were conducted between 0800 and 1600 h with a 1 h break at midday. During each survey, two observers recorded on magnetic tape the numbers of Fulvous Whistling-Ducks and habitats encountered within their respective transects on opposite sides of the aircraft. When two different habitats fell within the transect width, the habitat representing the greatest percentage was recorded. Starting and ending times for each transect also were recorded. Results for each observer were summed for each transect; thus,

TABLE 1

ABUNDANCE (KM²) OF HABITATS WITHIN TRANSECTS DURING FIVE MONTHLY AERIAL SURVEYS IN SOUTHWESTERN LOUISIANA, MAY 1984–APRIL 1985

Habitats	Apr.	May	June	July	Aug.	$\bar{x}$ (SD)
Disked fields	120.5	125.5	118.6	14.0	11.5	78.0 (59.6)
Ditches/canals	6.7	6.7	6.0	5.9	6.4	6.3 (0.4)
Flooded disked fields	25.1	na[a]	0.1	0.4	1.0	5.3 (1.1)
Flooded harvested rice fields	na	na	na	na	20.7	
Flooded pastures	1.3	0.5	2.8	4.0	1.8	2.1 (1.3)
Flooded soybeans	na	na	na	0.5	3.1	
Fresh marsh	25.1	26.4	24.4	23.0	27.4	25.3 (1.7)
Harvested rice fields	na	na	na	na	34.7	
Pastures/fallow fields	73.8	57.0	46.6	49.5	58.0	57.0 (10.6)
Ponds/open water	7.2	6.0	9.2	4.9	3.8	6.2 (2.1)
Residential/industrial	19.1	18.6	17.6	16.7	18.8	18.1 (1.0)
Rice	13.6	66.8	74.8	78.6	21.1	51.0 (31.1)
Sorghum/corn	13.4	3.8	2.7	4.6	2.9	5.5 (4.5)
Soybeans	na	na	na	106.1	102.5	
Woods	15.6	18.6	18.1	19.6	18.8	18.0 (1.5)

[a] na = not available.

results represent a 500-m wide transect. Amount of time in seconds over each habitat type was determined from recordings. This time was summed for each habitat type for each transect. Transect times for all surveys were corrected to a mean time to compensate for ground speed differences.

Population estimates, densities, and sampling variances were computed assuming a simple random sample (Cochran 1977) of transects from the survey area. Due to the small number of nonzero observations per habitat per transect per month, use of a ratio estimator was not feasible. Additionally, because our data set contained a few extreme values, mean numbers of ducks per month and standard errors were based on a logarithmic transformation. We obtained estimates of the Fulvous Whistling-Duck in the agricultural areas of southwestern Louisiana by multiplying the mean number of ducks per month per km² by the total area as delineated by Meanley and Meanley (1959). No adjustments for visibility bias were made.

Fifteen habitat types were identified in the rice belt of southwestern Louisiana during spring and summer months (Table 1). More than 75% of the area surveyed was in agricultural production throughout the period. Amount of nonagricultural land (ditches/canals, freshwater marsh, ponds/open water, residential/industrial, and woods) varied little among surveys. Conversely, abundance of soybeans, rice, disked fields, and flooded disked fields changed substantially between consecutive surveys. Disked fields were the most abundant habitat sampled during April, May, and June; soybeans were most abundant in July and August. Pastures/fallow fields were the second most abundant habitat sampled in April, but rice was second most abundant in all other months. Ten habitat types were available in all surveys. Flooded pastures were the least abundant habitat of those available in all surveys. Soybeans and flooded soybeans were observed only during July and August; harvested rice fields and flooded harvested rice fields were recorded only during August.

TABLE 2

NUMBERS OF FULVOUS WHISTLING-DUCKS (NUMBERS OF FLOCKS), BY HABITAT TYPE, OBSERVED DURING FIVE AERIAL SURVEYS OVER THE RICE BELT OF SOUTHWESTERN LOUISIANA, MAY 1984–APRIL 1985

Habitats	Apr.	May	June	July	Aug.
Disked fields	0 (0)	20 (3)	1 (1)	0 (0)	0 (0)
Ditches/canals	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)
Flooded disked fields	524 (16)	na[a]	0 (0)	0 (0)	0 (0)
Flooded harvested rice fields	na	na	na	na	213 (87)
Flooded soybeans	na	na	na	75 (1)	0 (0)
Harvested rice fields	na	na	na	na	21 (4)
Pastures/fallow fields	3 (1)	0 (0)	1 (1)	2 (1)	30 (2)
Ponds/open water	14 (2)	0 (0)	1 (1)	30 (1)	0 (0)
Residential/industrial	18 (1)	0 (0)	0 (0)	0 (0)	0 (0)
Rice	45 (4)	159 (30)	36 (27)	57 (13)	3 (1)
Soybeans	na	na	na	5 (1)	0 (0)
Mean flock size	12.2	6.0	1.1	23.3	6.4
(SD)	(11.8)	(1.0)	(0.2)	(31.2)	(5.8)

[a] na = not available.

Fulvous Whistling-Ducks were most abundant in April; fewest birds were seen in June (Table 2). Numbers of flocks (i.e., groups of two or more birds) were largest in August and least in July. Mean flock size decreased from April through June, but was greatest in July (Table 2). Greatest numbers of Fulvous Whistling-Ducks were in flooded disked fields but this habitat type was only used in April. The most flocks per habitat were recorded in flooded harvested rice fields during August, the only month this habitat type was available (Table 2). Fulvous Whistling-Ducks were never observed in freshwater marsh, flooded pastures, woods, or the sorghum (*Sorghum bicolor*)/corn (*Zea mays*) habitat type. Numbers of habitats used by ducks varied from six in April to two in May.

Densities of Fulvous Whistling-Ducks in the rice belt of southwestern Louisiana were greatest in flooded soybeans in July (150.0/km^2), but little of this habitat type (0.5 km^2) was available during that month. Mean densities in rice, the only type used all months, were 1.41 (SD = 1.4)/km^2. Monthly densities (ducks/km^2) varied from 0.58 in April to 0.11 in June (Table 3). The month with the lowest density had the lowest variance associated with the estimate. Within the rice belt's approximately 12,500 km^2 (Fig. 1), which is the breeding range of the Fulvous Whistling-Duck in Louisiana (Meanley and Meanley 1959), we estimated 7268 Fulvous Whistling-Ducks in April 1985 with an approximate 95% confidence interval of 2950 to 17,900.

Fulvous Whistling-Ducks were not observed during our March survey. Lowery (1974) reported that this species was recorded for Louisiana every month except February, and Meanley and Meanley (1959) stated that this duck concentrates in freshwater marshes of Vermilion and Cameron parishes before rice planting begins in March and April. Our transects terminated near the northern edge of the freshwater marsh, so we may have sampled insufficient freshwater marsh to record this duck, or else densities were so low along transects that the ducks were not detected within the transects. We did not conduct a survey in

TABLE 3

ESTIMATES OF FULVOUS WHISTLING-DUCK DENSITY DURING FIVE AERIAL SURVEYS OVER THE RICE BELT OF SOUTHWESTERN LOUISIANA, MAY 1984–APRIL 1985

	Ducks/km²	Variance	95% confidence limit	
			Lower	Upper
April	0.58	2.95	0.32	1.43
May	0.18	2.41	0.11	0.41
June	0.11	0.83	0.82	0.18
July	0.13	1.54	0.87	0.25
August	0.16	3.14	0.86	0.40

September. In October, no Fulvous Whistling-Ducks were recorded on transects, suggesting that most had moved from the rice belt during September. McCartney (1963) reported that few Fulvous Whistling-Ducks were observed during aerial surveys in September and October. We found, as did Meanley and Meanley (1959) and Bolen and Rylander (1983), that Fulvous Whistling-Ducks are closely associated with rice culture. About 90% of individuals observed were in rice fields during all months except July, when 34% were in this habitat type. Largest concentrations were in flooded disked fields in April and in flooded harvested rice fields in August. This species feeds at night on rice seed in newly water-planted fields during spring and on weed seeds in harvested rice fields in the fall (Bolen and Rylander 1983). We suggest that food availability influenced habitat selection during the day also. Availability of soybean seeds and/or weed seeds may have accounted for the high use of flooded soybeans during July when soybeans were being planted. Habitats with standing surface water appear to be preferred during the day by Fulvous Whistling-Ducks. During April, all use of disked fields was in those flooded, even though about five times as much of the nonflooded disked-fields habitat type was available. During July, only 0.5% of soybeans were flooded, yet over 90% of the ducks that used soybeans were in flooded soybeans. While similar amounts of flooded and nonflooded harvested rice fields were available in August, 90% of observed ducks was in the flooded habitat.

Differences among surveys in numbers of Fulvous Whistling-Ducks, numbers of flocks, and mean flock size appear to reflect breeding chronology, changes in cover, and observer visibility. Greatest numbers of this species and the second largest flock size were observed in flooded disked fields during April. McCartney (1963) reported that Fulvous Whistling-Ducks often congregate on the breeding grounds shortly after arriving in mid-April, but soon disperse in groups of 8–75 individuals. Similar behavior of whistling-ducks observed along our transects in April could account for the large flock sizes recorded. Also, ducks could be easily seen in flooded disked fields, which contributed to the large numbers recorded. Both numbers of ducks and mean flock size decreased during May and June. Pair formation and nesting activity during these months (Meanley and Meanley 1959) would explain reduced flock size. The reduction in numbers of ducks observed in May and June probably reflects visibility limitations of the survey due to increased vegetation height and density, rather than an actual reduction in duck numbers. A negative bias due to vegetation has been previously documented by Martinson and Kaczynski (1967).

The large mean flock size (23.1) recorded in July was influenced by the single flock of 75 birds in a flooded soybean field. Mean flock size of 4.4 in rice fields during the same month is probably more representative. Mean flock size was 6.4 in August, when Fulvous Whistling-

Ducks begin moving into large ponds, lakes, openings in rice fields and flooded rice stubble (Meanley and Meanley 1959). The large increase in numbers of ducks observed in August reflects recruitment and better visibility after the rice was harvested.

The only individuals seen in the residential/industrial habitat type (18) were airborne and probably were moving from one area to another. We estimated that approximately 7300 fulvous Whistling-Ducks were in the rice belt of Louisiana during April 1985. These numbers are 25% less than the 10,000 estimated in Louisiana for late summer 1975 by Flickinger et al. (1977). Meanley and Meanley (1959) reported that nesting densities of this species were greater in the northern part of the rice belt than in rice fields adjacent to the coastal marsh. Because we terminated our transects when we crossed US 90, or when we encountered large contiguous areas of woods, residences, or soybean fields, our transects did not extend to the northern limits of the rice belt. If nesting densities were higher in suitable habitat along the northern border of the rice belt as reported by Meanley and Meanley (1959), the mean number of ducks we calculated could have been higher, thus resulting in a higher estimate. Notwithstanding, our estimates suggest that the present population of the Fulvous Whistling-Duck in the rice belt of southwestern Louisiana has benefited from the elimination of aldrin as a pesticide. Because of the continued use of pesticides for rice production in this region, additional surveys could be useful in further monitoring the numbers of this unique waterfowl species.

Acknowledgments.—This paper was approved for publication by the Director of the Louisiana Agricultural Experiment Station as manuscript number 87-22-1498. The project was funded by the Louisiana Department of Wildlife and Fisheries to Louisiana State University. Research was conducted under the auspices of the Louisiana Cooperative Fish and Wildlife Research Unit, Louisiana Department of Wildlife and Fisheries, U.S. Fish and Wildlife Service, Louisiana State University, and Wildlife Management Institute, cooperating. We thank J. Nassar and D. Hayden for assisting with aerial surveys. We thank G. Daigle, Louisiana Department of Wildlife and Fisheries, for piloting the survey aircraft.

LITERATURE CITED

BOLEN, E. G. AND M. K. RYLANDER. 1983. Whistling-Ducks; zoogeography, ecology, anatomy. Spec. Pub., Museum Texas Tech. Univ., Texas Tech Press, Lubbock, Texas.

COCHRAN, W. G. 1977. Sampling techniques. 3rd ed. John Wiley and Sons, New York, New York.

FLICKINGER, E. L. AND K. A. KING. 1972. Some aspects of Aldrin-treated rice in Gulf Coast wildlife. J. Wildl. Manage. 36:706–727.

———, D. S. LOBPRIES, AND H. A. BATEMAN. 1977. Fulvous Whistling-Duck populations in Texas and Louisiana. Wilson Bull. 89:329–331.

LOWERY, G. H., JR. 1974. Louisiana birds. 3rd ed. Louisiana State Univ. Press, Baton Rouge, Louisiana.

MARTINSON, K. K. AND C. F. KACZYNSKI. 1967. Factors influencing waterfowl counts on aerial surveys, 1961–66. U.S. Fish and Wildl. Serv. Spec. Sci. Rep. 105.

MCCARTNEY, R. B. 1963. The Fulvous Tree Duck in Louisiana. La. Wildl. and Fish. Comm., New Orleans, Louisiana.

MEANLEY, B. AND A. G. MEANLEY. 1959. Observations on the Fulvous Tree Duck in Louisiana. Wilson Bull. 71:33–45.

NORTON-GRIFFITHS, M. 1978. Counting animals. Handbook N. 1, 2nd ed. Afr. Wildl. Leadership Found., Nairobi, Kenya.

PHILLIP J. ZWANK, PAUL M. MCKENZIE, *Louisiana Coop. Fish and Wildl. Res. Unit, Louisiana State Univ. Agric. Center, 227 For.-Wildl.-Fish. Bldg., Baton Rouge, Louisiana 70803,* AND

E. BARRY MOSER, *Dept. of Exp. Stat., Louisiana State Univ. Agric. Center, Baton Rouge, Louisiana 70803.* (Present address of PJZ: *Oklahoma Coop. Fish and Wildl. Res. Unit, Oklahoma State Univ., Stillwater, Oklahoma 74078.*) *Received 28 Oct. 1987, accepted 10 Feb. 1988.*

Wilson Bull., 100(3), 1988, pp. 494–496

Long-distance dispersal of an adult Red-cockaded Woodpecker.—The Red-cockaded Woodpecker (*Picoides borealis*) is an endangered species endemic to mature pine forests of the southeastern United States, and is especially characteristic of longleaf pine (*Pinus palustris*) and forest lacking in hardwood understory. Such habitat has grown increasingly sparse and fragmented in recent years, and the remaining populations of the bird are becoming increasingly isolated as a result (USFWS 1985, Ligon et al. 1986, Jackson 1987). As populations become isolated, the possibility of dispersal between them becomes an important issue, particularly in maintenance of genetic variability (Reed et al. 1988). In this note we describe a long-distance dispersal by an adult female Red-cockaded Woodpecker. She moved from an isolated group in the Piedmont of North Carolina to a group, 90 km away, within a large population in the Sandhills. The individual involved was banded with three color bands and a USFWS aluminum band as an adult in 1984. At that time she resided in an isolated group in the Piedmont, near the Shearon Harris nuclear power plant on land owned by Carolina Power and Light Company in southwestern Wake County. In 1984, the female was paired and fledged two young. The pair remained at the site in 1985 and nested again, but the nest failed. During the winter of 1985–1986, the male (banded) disappeared. The female was last observed there on 10 April, 1986, when she was involved in aggressive interaction with one of two unbanded birds that moved into the site. She was absent on 17 April, and from that date on, only the two new birds resided there.

The group at Shearon Harris to which the female belonged is part of a sparse, little known population. In 1981, only four groups could be found in the entire Piedmont of North Carolina, including two in Wake County, and only seven groups in the Coastal Plain counties adjacent to Wake County to the east (Carter et al. 1983a). In 1984–1986, the Shearon Harris group was 50 km from the next nearest known group. During this time, three unbanded Red-cockaded Woodpeckers were observed at Shearon Harris, suggesting that there were some unknown groups remaining in the area. After disappearing from Shearon Harris, the female was next seen 90 km to the southwest on Camp Mackall, a military base in Richmond and Scotland counties in the Sandhills. She was first seen in the Sandhills on 23 May 1986, 43 days after last being seen in Wake County, and was identified from her color-band combination. She was recaptured on 28 May, and her identity was confirmed from her aluminum band number. The minimum rate of movement of the female was 2 km/day, and the actual rate is presumably higher as it is unlikely that we observed her the first day she arrived in the Sandhills. Observers visited the site to which she moved every 9 days during the dispersal period, but no birds were contacted prior to 23 May.

The female was paired with an unbanded male when first observed at Camp Mackall. The pair failed to nest in 1986, and both birds had disappeared by the 1987 breeding season. The large Sandhills population (450 groups), including all the groups on Camp Mackall, has been studied intensively since 1979 (Carter et al. 1983b; Walters et al. 1988). Although not a certainty, it is likely that if the female moved within the Sandhills in 1986–1987, she would have been detected in her new group. Thus the female likely did not reproduce following her dispersal from the Piedmont to the Sandhills.