

LITERATURE CITED

- BAILEY, A. M. AND R. J. NIEDRACH. 1932. Domain of the camp robber. *Am. Forests* 38: 492.
- BRADBURY, W. C. 1918. Nesting of the Rocky Mountain Jay. *Condor* 20:197–208.
- BREWER, T. M. 1879. The Rocky Mountain Whiskey-jack. *Bull. Nuttall Ornith. Club* 4: 239–240.
- BROWN, J. L. 1963a. Social organization and behavior of the Mexican Jay. *Condor* 65: 126–153.
- . 1963b. Aggressiveness, dominance and social organization in the Steller Jay. *Condor* 65:460–484.
- . 1987. *Helping and communal breeding in birds*. Princeton Univ. Press, Princeton, New Jersey.
- BURNELL, K. L. AND D. F. TOMBACK. 1985. Steller's Jays steal Gray Jay caches: field and laboratory observations. *Auk* 102:417–419.
- CLAPP, R. B., M. K. KLIMKIEWICZ, AND A. G. FUTCHER. 1983. Longevity records of North American birds: Columbidae through Paridae. *J. Field Ornith.* 54:123–137.
- FARNER, D. S. 1947. An interesting recovery of a banded Gray Jay. *Bird-banding* 18: 31–32.
- HURLBUTT, C. A. 1932. At home with the camp robber. *Bird-Lore* 34:383–385.
- KAPLAN, E. L. AND P. MEIER. 1958. Nonparametric estimation from incomplete observations. *J. Am. Stat. Assoc.* 53:457–481.
- LAWRENCE, L. D. K. 1947. Five days with a pair of nesting Canada Jays. *Can. Field-Nat.* 61:1–11.
- . 1968. Notes on hoarding nesting material, display, and flycatching in the Gray Jay (*Perisoreus canadensis*). *Auk* 85:138–139.
- NICHOLS, J. D., B. R. NOON, S. L. STOKES, AND J. E. HINES. 1981. Remarks on the use of mark-recapture methodology in estimating avian population size. Pp. 121–136 in *Estimating numbers of terrestrial birds*. Studies in Avian Biology No. 6 (C. J. Ralph and J. M. Scott, eds.). Cooper Ornithol. Soc., Los Angeles, California.
- RUTTER, R. J. 1969. A contribution to the biology of the Gray Jay (*Perisoreus canadensis*). *Can. Field-Nat.* 83:300–316.
- SKINNER, M. P. 1921. Notes on the Rocky Mountain jay in the Yellowstone National Park. *Condor* 23:147–151.
- WARREN, O. B. 1899. A chapter in the life of the Canada Jay. *Auk* 16:12–19.
- WOOLFENDEN, G. E. 1975. Florida Scrub Jay helpers at the nest. *Auk* 92:1–15.
- AND J. W. FITZPATRICK. 1984. *The Florida scrub jay: demography of a cooperative-breeding bird*. Princeton Univ. Press, Princeton, New Jersey.
- JAMES C. HA AND PHILIP N. LEHNER, *Biology Dept., Colorado State Univ., Ft. Collins, Colorado 80523*. Received 20 Dec. 1989, accepted 20 Mar. 1990.

Wilson Bull., 102(4), 1990, pp. 702–706

Nest-site selection by Boat-tailed Grackles.—Female birds that choose nest sites that maximize their reproductive success should have a selective advantage. If females choose nest sites predictably, males may be able to monopolize females in the same sense that predictable resources can be monopolized by an individual (e.g., Brown 1964). It is therefore

important to examine environmental and biotic influences on female distribution in order to understand fully the mating system in a population (Wolf and Waltz 1988). In this paper I examine the factors influencing nest site choice by female Boat-tailed Grackles (*Quiscalus major*). In Florida, Boat-tailed Grackles commonly nest in cattail marches, although their nests are also found in buttonbush, willow, and palm trees (Bancroft 1987, Dunham 1988). Male Boat-tailed Grackles are territorial, but where females build nests extremely densely, males are apparently unable to defend exclusive territories (Bancroft 1987). I first show that nest site choice occurs and then examine the effects of that selection on nest success. Predation on nest contents is a major cause of failure among marsh-nesting birds (Kale 1965, Post 1981, Orians 1980). In this study, predation is implicated as the most important factor determining nest site choice.

Methods.—I studied five marshes in northern Hillsborough County, Florida between 1 March and 20 June 1987. These were: Adventure Island retention pond (AI), Bearss Extension pond (BE), Burrell Lake (BL), East Burrell Lake (EB), and Lake Forest (LF). The primary emergent vegetation on all marshes was cattail (*Typha* spp.), with willow (*Salix* spp.) and buttonbush (*Cephalanthus occidentalis*) along the shores in some places. AI and EB were retention ponds dug by humans; BL, BE, and LF were marshes modified by man.

Every week until 12 May, marshes were searched from a canoe for new nests. Usually I visited nests every three days to record nest contents; the longest interval between visits was seven days. Nests that had been torn down were assumed to have been depredated by large mammals such as raccoons (*Procyon lotor*). Nests were torn down on all marshes, suggesting that these predators were not deterred by the presence of alligators. If scat or chewed remains of eggs or nestlings were found in the nest, I considered rats responsible. Both rice rats (*Oryzomys palustris*) and black rats (*Rattus rattus*) were present in the marshes. No damage and no remains in the nest suggested predation by Fish Crows (*Corvus ossifragus*) or rat snakes (*Elaphe obsoleta*).

Nest-site characteristics that may affect predation include nest visibility, distance from shore, distance from open water, height of the nest above water, and depth of water under the nest (Willson 1966, Lenington 1980, Burger 1985). To estimate nest visibility to both avian and terrestrial predators, I counted the number of stems at nest height within 0.5 m of the nest. Cattail stems were separated into new and old; new cattails were completely green, whereas old cattails had turned, or started to turn, brown. I used two estimates of visibility from above: height of vegetation above the nest and amount of light reaching the nest (Westmoreland and Best 1985). The vertical distance from the bottom of the nest to the average height of the surrounding vegetation was measured to the nearest 10 cm. The light incident on each nest was measured with an incident light photometer between 11:00 and 13:00 EST, while the sun was nearly straight overhead. I checked light level in the open frequently, and light intensity at the nest is expressed as a percentage of direct sunlight.

The distance of each nest from the shore and from the nearest area of open water greater than 1 m across was measured to the nearest meter. Water level in each pond was recorded at each visit. Water depth at the nest and height of the nest bottom above water were calculated by adding or subtracting the change in water level between the day the nest was built and the day measurements were taken at the nest. Southwest Florida Water Management provided data on water levels from past years, from which average monthly water fluctuation was calculated.

Nests supported by more plant stems should be less likely to be blown over by the wind. The number and type of stems supporting the nest were counted.

I compared nest-site characteristics to characteristics of the available habitat in order to demonstrate nest site choice (Johnson 1980). Available habitat was determined as follows. Fifty 1-m² plots on each marsh were chosen randomly. In each plot, the number of old and

new cattail stalks with at least 30 cm exposed above the water in a 1-m diameter circle were counted. Depth of water, height of cattails above water and light intensity at breast height were measured in the center of each plot. Distance to the shore and nearest open water from the center of each plot were determined from a map (see below).

I compared nest-site characteristics to the characteristics of the entire marsh using the Kolmogorov-Smirnov test (D. H. Johnson pers. comm.). This method shows which habitat is preferred relative to the habitat available; it does not indicate absolute habitat preference.

At the end of the study, marshes and nests were mapped using an alidade, stadia rod, and plane table. Distances between nests, from nests to shore, and from random plots to shore were measured from these maps.

Results.—I found 371 nests on the five marshes studied. Of these, 21 never contained eggs. An approximately equal number of nests were in cattails adjoining the shore and on cattail islands (islands: 176 nests, shoreline: 156 nests). Almost half (45.7%) of all nests fledged young, and 75.8% of nest failure was caused by predation. I found scat from black rats in 15 nests, eggshell fragments in 51 nests, and chewed nestling remains in 12 nests (12 nests contained both scat and eggshell or nestling remains). In total, rats ate the contents of 48.6% of the depredated nests. The second most common cause of failure was flooding (17.7% of failed nests). A 7-day period of rain between 28 March and 4 April raised water levels as much as 53 cm (BE). The resulting variance in water level was greater than the 29-year variance for March or April on local lakes (March: $F = 1.65$, April: $F = 2.02$; $P < 0.05$). Because 54.2% of the nests active on BE at that time were flooded, the marsh was deleted from further analyses. Only 4.9% of all nests were abandoned (9.1% of failed nests). Of the 371 nests, two failed because they were built in cattails that tipped, and two were constructed in such a way that eggs or young fell out.

Nests were in denser cattail and deeper shade than random sites on all four marshes (Kolmogorov-Smirnov, $P < 0.01$) and farther from shore than random sites on three marshes (LF, BL $P < 0.05$; EB, $P < 0.01$). Cattails were shorter around nests than on random sites (EB and LF, $P < 0.05$), and nests were farther from open water than were random sites (AI, $P < 0.01$, BL, $P < 0.05$).

Nest sites used did not differ between marshes (ANOVA, all $P > 0.05$). Therefore, I combined data from all marshes to test for differences between successful and unsuccessful nests. Successful nests differed significantly from unsuccessful nests in six of the 12 characteristics measured (Table 1). Most of these characteristics also differed between nests depredated by rats and successful nests (Table 1).

Discussion.—Rice rats are major predators on bird nests in Georgia and Florida marshes (Kale 1965, Post 1981). In this study as well, half the nests that failed were depredated by rats, both rice rats and black rats. Rice rats are good swimmers and climbers (Wolfe 1982), and black rats climb well but are reluctant swimmers (van den Brink 1967). Rice rats nest in salt marshes (Post 1981), but I found no rat nests in the freshwater marshes I studied. Rats probably nested on shore and traveled out into the marsh each night; thus rat predation was more common on nests close to shore than on nests far from shore. Higher nests were safer, suggesting that rats were swimming out to nests or climbing near water level. Predation was higher on nests built in older cattails than on nests built in newer cattails, suggesting that rats spend more time in old cattail stands. Cattails that have aged and turned brown are sturdier than young green cattails and may be easier for rats to climb. Another possibility is that rats use regular paths through the cattails and are reluctant to explore new areas.

Rat predation was more likely on nests over deeper water than average. This may simply result from the fact that rat predation was most common on the two deeper marshes in the study. Older cattail stands are taller than young cattail stands ($P < 0.001$, Kolmogorov-Smirnov test).

TABLE 1
NEST-SITE CHARACTERISTICS FOR SUCCESSFUL AND UNSUCCESSFUL NESTS OF BOAT-TAILED GRACKLES IN THE TAMPA BAY REGION OF FLORIDA, ALL FOUR MARSHES COMBINED^a

Characteristic	Median successful	Median unsuccessful	Predator		
			Snake	Rat	Raccoon
Total stem density ^b	141	146	139	140	149
New cattail density ^b	82	72 ^d	40	61 ^d	76
Old cattail density ^b	49	69 ^d	69 ^c	73 ^d	71
Woody stem density ^b	0	0	0	0	0
New cattail support (number)	10	9	10	8	7
Old cattail support (number)	7	8	8	8	9
Woody stem support (number)	0	0	0	0	0
Water depth (cm)	91	99 ^d	95	106 ^d	105
Nest height (cm)	51	44 ^d	51	42 ^c	34 ^d
Cattail height (cm)	140	145	140	160 ^c	130
Distance to open water (cm)	140	100 ^c	100	100	70 ^c
Distance to shore (m)	5.7	5.2 ^c	81	56 ^d	84
Light intensity (% of direct sun)	37.5	33.0	24	35	68 ^c

^a Nests that never contained eggs excluded.

^b Number per 1 m diameter circle.

^c Different from successful nests at $P < 0.05$, Kolmogorov-Smirnov test.

^d Different from successful nests at $P < 0.01$, Kolmogorov-Smirnov test.

Nests may be visible from water level if they are near open water, especially if the surrounding cattails are less dense. Successful nests were farther from the open than were nests that had been torn down. All but one nest that had been torn down was closer to the water than the average successful nest.

Depredated nests that contained no remains were in denser old cattail than successful nests. Sturdy old cattails may be easier for a snake to climb or more likely to hold the weight of a Fish Crow landing on the nest.

Water levels in the area commonly fluctuate 6–8 cm in March and April, posing little threat to nests (see also Bancroft 1986). However, the unusual week-long storm during peak breeding showed the potential importance of flooding. Unfortunately, nest height could not be compared to any characteristic of random sites. Nests built high enough off the water to avoid the flood clearly were more likely to be successful than were nests that got wet. However, even when flooded nests were removed from the analysis, lower nests were less likely to fledge young.

Females chose nest sites with characteristics that males might be able to predict. This predictability could allow territorial behavior to be economically feasible, as long as nests are not too tightly clumped. Nest site choice had a positive effect on reproductive success; that is, nests were more likely to be successful at preferred sites. Rat predation was the form of nest failure most strongly affected by nest-site characteristics, which suggests that nest sites may be selected to minimize the impact of rat predation.

Acknowledgments. — This research was completed as part of the requirement for a Master's degree at the Dept. of Biology, Univ. of South Florida. I appreciate comments provided by E. McCoy, H. Mushinsky, and G. Woolfenden, by ornithology graduate students, and by B. Kaiser and R. Curry. J. Waage and D. Morse read earlier copies of this manuscript. I

am grateful to J. Ballard, the Dept. of Public Works of the City of Tampa, Florida, and the Dept. of Transportation of the State of Florida for access to study sites. I thank D. Fleck, B. Mazzei and J. Kane for help in the field. M. Lopez and J. Whelan of the Southwest Florida Water Management District provided local maps and water level data, respectively.

LITERATURE CITED

- BANCROFT, G. T. 1986. Nesting success and mortality of the Boat-tailed Grackle. *Auk* 103:86–99.
- . 1987. Mating system and nesting phenology of the Boat-tailed Grackle in central Florida. *Florida Field Nat.* 15:1–18.
- BROWN, J. L. 1964. The evolution of diversity in avian territorial systems. *Wilson Bull.* 76:160–169.
- BURGER, J. 1985. Habitat selection in temperate marsh-nesting birds. Pp. 253–281 in *Habitat selection in birds* (M. L. Cody, ed.). Academic Press, Inc., New York, New York.
- DUNHAM, M. L. 1988. Habitat quality, nest density and reproductive success in female Boat-tailed Grackles. M.S. thesis, Univ. of South Florida, Tampa, Florida.
- JOHNSON, D. H. 1980. The comparison of usage and availability measurements for evaluating resource preference. *Ecology* 61:65–71.
- KALE, H. W. 1965. Ecology and bioenergetics of the Long-billed Marsh Wren *Telmatodytes palustris griseus* (Brewster) in Georgia salt marshes. *Publ. Nuttall Orn. Club* 5:1–142.
- LENINGTON, S. 1980. Female choice and polygyny in Red-winged Blackbirds. *Anim. Behav.* 28:347–361.
- ORIAN, G. H. 1980. Some adaptations of marsh-nesting blackbirds. *Monogr. Pop. Biol.* 14:1–295.
- POST, W. 1981. The influence of rice rats *Oryzomys palustris* on the habitat use of the Seaside Sparrow *Ammodramus maritima*. *Behav. Ecol. Sociobiol.* 9:35–40.
- VAN DEN BRINK, F. H. 1967. A field guide to the mammals of Britain and Europe. Collins, London.
- WESTMORELAND, D. AND L. B. BEST. 1985. The effect of disturbance on Mourning Dove nesting success. *Auk* 102:774–780.
- WILLSON, M. F. 1966. Breeding ecology of the Yellow-headed Blackbird. *Ecol. Monogr.* 36:51–77.
- WOLF, L. L. AND E. C. WALTZ. 1988. Oviposition site selection and spatial predictability of female white-faced dragonflies (*Leucorrhinia intacta*) (Odonata: Libellulidae). *Ethology* 78:306–320.
- WOLFE, J. L. 1982. *Oryzomys palustris*. *Mamm. Sp.* 176:1–5.

MARTHA L. DUNHAM, *Div. Biology and Medicine, Box G, Brown Univ., Providence, Rhode Island 02912. Received 9 Oct. 1989, accepted 1 Feb. 1990.*

Wilson Bull., 102(4), 1990, pp. 706–710

Turkey Vulture food habits in southern Ontario.—Where Turkey Vultures (*Cathartes aura*) live sympatrically with other New World vultures (Cathartidae), they forage individually or in widely scattered small groups and usually feed on small carcasses (Rabenold 1983, Paterson 1984, Houston 1986, Coleman and Fraser 1987). However, where Turkey Vultures