

Nest Box Use and Nesting Success of House Wrens (*Troglodytes aedon*) in a Midwestern Wetland Park¹

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ABSTRACT. I placed 67 milk-carton nest boxes designed for Prothonotary Warblers (*Protonotaria citrea*) in a suburban Indianapolis wetland park and monitored them during the 2000 nesting season. My intent was to determine if nest box use and/or nest success by warblers or other cavity nesters were influenced by distance to water, recreational activity, tree diameter, canopy shading, or box height. No warblers nested, but 19 boxes (28%) were used by House Wrens (*Troglodytes aedon*; 24 nests) or Carolina Chickadees (*Poecile carolinensis*; 1 nest). Only 23% of wren nests fledged young. Failures were due to predation, usually by mammals that ripped open the cardboard boxes. Tree diameter significantly influenced box use and potentially nest success (wrens preferred smaller trees). Other variables did not significantly affect box use or nest success. Milk-carton boxes were acceptable to House Wrens but were more vulnerable to mammalian predators in this suburban park than in studies of Prothonotary Warblers in wilder settings.

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INTRODUCTION

Cavity nesting bird species vary in the characteristics of their nest sites (Li and Martin 1991). For species willing to use them, nest boxes can help identify environmental characteristics that influence site selection and nest outcome. In this study I placed nest boxes in a suburban Indiana wetland park to determine nest-site preferences of the locally rare Prothonotary Warbler (*Protonotaria citrea*). Boxes were modified milk cartons, a material that has been successfully used in Prothonotary Warbler studies (Fleming and Petit 1986). Tree diameter, box height, distance to water, shading, and level of human recreational activity (independent variables) were varied to examine their relation to use and nest success (dependent variables). The boxes were not used by warblers, and I saw none in the area; instead, boxes were used commonly and almost exclusively by House Wrens (*Troglodytes aedon*). House Wrens nest readily in wooded swamps (Johnson 1998) and sometimes out-compete other wetland cavity-nesters such as the Prothonotary Warbler either by occupying available sites or destroying existing nests (Walkinshaw 1941; Flaspohler 1996). Box use and nest fates were analyzed to provide information on (a) House Wren nesting behavior in a suburban wetland, and (b) on the suitability of milk-carton nest boxes in this setting.

MATERIALS AND METHODS

Study Area

The study was conducted at Eagle Creek Park in northwestern Indianapolis, IN. The park is bordered on the north and east by interstate highways, on the west by a road and residential neighborhoods, and on the south by a road. The park covers 2100 hectares, 525

of which are bodies of water (reservoir, lake, ponds, marshes, and streams) (Indy Parks and Recreation 2000). Deciduous woodlands and meadows account for much of the remainder. Recreational use is intensive and includes fishing, swimming, boating, walking, and biking. Approximately 7.6% of the parklands are nature preserves (Indiana Department of Natural Resources 1999) where recreational activity is low.

Data Collection and Analysis

Using clean half-gallon cardboard milk-cartons obtained from a dairy, I made nest boxes designed for Prothonotary Warblers (Fleming and Petit 1986). I made the entryways 2.54 cm in diameter, with the bottom of the entry 10.5 cm from the bottom of the box, and punched several holes for drainage. The rest of the milk-carton was unmodified. Interior dimensions of the boxes were 9.5 cm in width, 9.5 cm in depth, 19.5 cm in height at the sides, and 22.0 cm in height at the center. The boxes were painted brown and paint was sprayed into the opening so that the cavity would appear dark. I mounted the boxes between 13 and 29 April using brown strapping tape. All 67 boxes were mounted on trees within 30 m of a body of water at heights of 0.7–2.1 m above ground. Twenty-five were directly over water. I placed 34 boxes in areas heavily used for recreation (lakes and ponds) and 33 in secluded areas (streams and marshes). For each box, the location, distance from water (mean \pm SD: 4.0 \pm 5.8 m at time of box placement), box height (1.58 \pm 0.24 m from bottom of box to ground or water), tree diameter (16.0 \pm 6.9 cm at point of box attachment), and shading (full, partial, or none) were recorded.

The boxes were numbered and monitored once weekly for 13 weeks (6 May–29 July). During nest checks I removed the box's lid with bare hands, examined the contents with a mirror, and recorded the presence of nest material, the number of eggs or nestlings, nestling condition, and any change in proximity to water. If a box had been disturbed, I described its condition and the

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remaining contents. After fledging or nest failure, remaining material was removed. Damaged boxes were repaired when possible, and only two boxes (both in secluded areas in the last month of the study) were damaged beyond repair. By 29 July, nesting activity had ceased and the boxes were removed.

Nests were scored as successful if no evidence of predation was found and sufficient time had elapsed for fledging: at least 11 days for incubation and 15 days for nestling stage (Johnson 1998). Otherwise, predation was assumed. Predation was attributed to a mammal if disturbance was obvious (rips, tears, disturbed contents) and to an unknown source (potentially snake, mouse, or other House Wren) if no disturbance was obvious but eggs or nestlings had vanished. I scored as dummy nests those boxes containing nest material but lacking a completed nest. Male House Wrens commonly construct such nests, which consist of a few twigs and function as invitations for females to continue nest building (Kaufman 1996; Johnson 1998). Dummy nests were not considered "used" in any calculations. If a box was found partially destroyed with no nest material, I scored this as intended predation on an empty box.

I examined the effects of five nest-site characteristics on (a) nest box use and (b) nest outcome using two-tailed univariate tests. The null hypothesis was that a variable's mean value did not differ between used and unused boxes, or between successful and failed nests. Two-tailed tests were used because no prediction was made about which mean would be greater. For the three continuous variables (tree diameter, box height, distance to water), I used *t*-tests when comparing used and not used boxes because the sample was large ($n = 67$), and Wilcoxon rank sums tests when comparing successful and depredated nests because the sample size was small ($n = 7$). Contingency tables were used to analyze two categorical variables, recreational activity and shading: chi-square tests for goodness of fit were employed for box use and Fisher's exact test for the smaller sample of nest outcomes. For tests of association with shading, boxes in no shade (the least common category, $n = 6$) were omitted to avoid low expected cell values. Statistical analyses were carried out using SAS (1996) software.

RESULTS

House Wrens used 18 nest boxes (27%), laid 24 clutches of eggs, and built 9 dummy nests. Four boxes were used twice and 1 was used 3 times. In all cases of multiple use, the second and third clutches were initiated after 1 (or 2) clutches had failed, and thus likely were replacement clutches. A Carolina Chickadee (*Poecile carolinensis*) pair nested unsuccessfully. I saw no other bird species use or investigate the boxes, although other small cavity nesters such as Carolina Wrens (*Thryothorus ludovicianus*) and Tufted Titmice (*Parus bicolor*) breed in the park. Two boxes were occupied by breeding White-footed Mice (*Peromyscus leucopus*). All statistics reported below refer to House Wrens.

The first 9 clutches (38%) were initiated in the second week of observation (13-20 May). Thereafter, the rate of

clutch initiation declined to ≤ 3 clutches per week and terminated during the week of 22-29 July. Average clutch size was 6.5 eggs (range, 5-7 eggs; $n = 17$ completed clutches). Clutch size was 6 ($n = 3$) or 7 ($n = 6$) in clutches that survived to hatching.

Five nests (23%) fledged at least 1 young; 17 nests (77%) were preyed upon. Two outcomes could not be determined. Thirteen predation incidents apparently were by mid-sized mammals that clawed, chewed, tore, or smashed the boxes, or removed lids. Four predation incidents were by animals that did not damage the box. No human vandalism was detected. Of the five second clutches, 4 (80%) were depredated and the outcome of 1 was unknown. The only third clutch was depredated. There were an additional 10 attacks on boxes: 2 on mouse nests (with predation of contents), 2 on dummy nests, and 6 on empty boxes. Of the latter, 1 involved a box that had previously fledged young, 2 followed previous attacks, and 3 occurred in boxes that had never been used.

Only 1 of 5 nest site characteristics, tree diameter at box height, had a significant effect on box use or nest outcome (Table 1). Wrens preferred boxes on smaller trees ($p = 0.002$). Despite this preference, small trees were not safer than large trees; there was a marginally significant ($p = 0.10$) trend for depredated nest boxes to be on smaller trees than successful boxes.

DISCUSSION

Acceptability of Cardboard Boxes

Studies of cavity nesting birds typically employ wooden boxes, which are relatively permanent and resistant to destruction by predators. However, cardboard boxes from modified milk-cartons are easily made and potentially suitable for a short-term study, if they are acceptable to nesting birds and not too vulnerable to predators. Previous published work using milk-carton boxes was conducted in rural Tennessee river valleys. There, Prothonotary Warblers used such boxes extensively and experienced low rates of nest predation (2-21%; Fleming and Petit 1986; Petit and others 1987; Petit 1989). In Eagle Creek Park, House Wrens used 18 milk-carton boxes, in some cases repeatedly, showing clearly that cardboard boxes are acceptable to House Wrens, at least in the first season of presentation. The 27% rate of box use was intermediate compared to studies using wooden boxes, for example, 17% in Ontario (Lumsden 1986), 37% in Wyoming (Finch 1989), and 49% in Maryland (Willner and others 1983). The rate of box use is undoubtedly influenced by population density and natural cavity availability, but these variables were not measured at Eagle Creek or in the cited studies.

High Nest Predation Rate

The 77% predation rate on House Wren nests in boxes at Eagle Creek Park was the highest yet reported for this species. In Wyoming, 27-32% of nests in wooden boxes failed (Finch 1989; Johnson and Kermott 1994). In rural Ohio, only 16% of nests failed in boxes of unspecified material (Robinson and Rotenberry 1991).

TABLE 1

Characteristics of nest boxes that were used (eggs laid) or not used by House Wrens, and of successful and depredated nests, with two-tailed hypothesis tests. For continuous variables, mean and standard deviation are given. For shade and recreational activity categories, numbers of nests are given.

Characteristic	Boxes		Nests	
	Used	Not used	Successful	Depredated
	<i>N</i> = 18	<i>N</i> = 49	<i>N</i> = 5	<i>N</i> = 12
Tree diameter (cm)	11.9 ± 4.7	17.6 ± 7.0	14.9 ± 4.8	11.2 ± 4.5
	<i>t</i> = 3.22, <i>P</i> = 0.002		Wilcoxon <i>T</i> = 61.00, <i>P</i> = 0.10	
Box height (m)	1.60 ± 0.16	1.58 ± 0.26	1.51 ± 0.32	1.59 ± 0.17
	<i>t</i> = 0.53, <i>P</i> = 0.60		Wilcoxon <i>T</i> = 42.50, <i>P</i> = 0.83	
Distance from water ^a (m)	4.1 ± 4.3	4.0 ± 6.3	4.9 ± 5.8	2.8 ± 3.5
	<i>t</i> = 0.03, <i>P</i> = 0.98		Wilcoxon <i>T</i> = 48.00, <i>P</i> = 0.79	
Recreational activity:				
High	8	25	3	4
Low	10	24	2	8
	$\chi^2 = 0.23$, <i>P</i> = 0.63		<i>P</i> = 0.59 (Fisher exact test)	
Full shade	6	21	1	5
Partial shade	11	23	3	7
	$\chi^2 = 0.76$, <i>P</i> = 0.38		<i>P</i> = 1.00 (Fisher exact test)	

^aAt time of box placement for box use; at time of nest building for nest outcome.

Failure rates ranged from 18-37% in natural cavities in Arizona and Wyoming (Li and Martin 1991; Martin and Li 1992; Johnson and Kermott 1994).

The high predation rate on nest boxes at Eagle Creek Park was clearly due to box vulnerability and to an ample number of predators. Nest boxes and their contents were easily accessible to predators: boxes were near the ground (0.7-2.1 m) which resulted in a short climb for ground mammals, cardboard lids were easily removed, and boxes were easily torn. This range of heights was similar to heights used in other House Wren nest box studies (1.2-2 m, Parren 1991; 1.5 m, Lumsden 1986; 1.5-2 m, Johnson and Kermott 1994; 2 m, Finch 1989, Purcell and others 1997), but was lower than average natural nest heights (3.6 m, Dobkin and others 1995; 4.1 m, Raphael and White 1985; 4.9 m, Sedgwick and Knopf 1990; 9.0 m, Li and Martin 1991). A factor contributing to predator abundance may be picnicking at the park, which results in food wastes that may act as a supplemental food source. Additionally, I made direct contact with the boxes as I checked them. It is possible that human scent left by this contact attracted predators. In contrast to my findings for House Wrens at Eagle Creek, boxes of the same design used by Prothonotary Warblers in rural Tennessee floodplains

had predation rates of only 2-21 % (Fleming and Petit 1986; Petit and others 1987; Petit 1989). The contrast between the Indiana and Tennessee studies must be due either to different abundances of predators or different predator behavior in suburban versus rural sites. Milk-carton nest boxes, being especially vulnerable to predation, may be unsuitable in areas where predators are abundant. Increasing box height may alleviate the problem, but would make nest monitoring more difficult.

Likely predators of the damaged boxes were raccoons (*Procyon lotor*), opossums (*Didelphis virginiana*), and Eastern fox squirrels (*Sciurus niger*). All were commonly seen in the park, either dead or alive (personal observation). The 4 cases of predation without damage to the box may have been caused by snakes, white-footed mice, or other House Wrens. *Peromyscus* mice prey on cavity-dwelling nestlings (Guillory 1987), and the observation of mice in 2 nest boxes supports this possibility. House Wrens attack conspecific nests and remove eggs while leaving the nest intact or nearly so (Belles-Isles and Picman 1986).

Nest Site Characteristics

The only variable to significantly affect box use was tree diameter; the mean diameter of trees supporting

used nest boxes was significantly less than that of trees with unused boxes. Similar patterns were noted in Iowa and Wyoming, where House Wrens using natural cavities occupied trees with trunk or limb diameters significantly smaller than those used by most other cavity nesters, which were larger species (Stauffer and Best 1982; Gutzwiller and Anderson 1987). Possibly, wrens were attracted to slender trees by some correlated attribute such as number of available perches. Curiously, small trees were not safer than large trees, and the trend was in the opposite direction. Because of the low sample size of used boxes ($n = 17$) the influences of environmental variables on nest fate could not be tested as strongly as their effects on box use.

This study was well designed to detect the influence of human recreational activity on nest site choice and nest fate, with equal numbers of boxes in preserves and high-recreation areas. However, no differences were observed between these areas. House Wrens frequent areas near human activity but are also common in wild areas (Johnson 1998). Recreation at the park is diurnal; if predation was mostly nocturnal, this could explain the lack of association between recreation level and nest outcome.

CONCLUSION

Tree diameter affected nest box selection by House Wrens (the wrens preferred smaller trees) and possibly predation rate (which was marginally significantly higher for boxes on small trees). Box height, distance from water, canopy shading, and recreational activity did not affect either box use or nest success. However, at low heights, milk-carton nest boxes may serve as unintentional traps for House Wrens, especially when predators are abundant. Further studies suggested by these results could investigate (1) why House Wrens prefer smaller diameter trees, especially if these increase nest predation risk; (2) whether House Wrens prefer wooden to milk-carton nest boxes; and (3) whether nest predation rates for other bird species are higher in suburban parks than in wilder settings.

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