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EFFECTS OF NEST BOX SIZE ON EASTERN BLUEBIRD NESTS

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Abstract.—Eastern Bluebird (*Sialia sialis*) clutch size and nesting success did not differ between large nest boxes (floor size = 143 cm^2) and small nest boxes (floor size = 71.5 cm^2). Nests in large boxes were significantly larger and taller than nests in small boxes. A greater percentage of nestlings returned from large boxes to nest on the study area; however, this difference needs confirmation with larger sample sizes. The results suggest that Eastern Bluebirds did not prefer either box size and that nesting performance was unaffected by box size.

EFECTO DEL TAMAÑO DE CAJAS DE ANIDAMIENTO EN *SIALIA SIALIS*

Resumen.—El tamaño de la camada y el éxito de anidamiento de *Sialia sialis* no es afectado por el tamaño de la caja en que aniden. El nido construido en cajas de mayor tamaño (fondo de 143 cm) resulto ser más grande y más alto que en las cajas pequeñas (fondo de 71.5 cm). Un mayor número de los individuos que nacieron en cajas grandes regresaron al área de estudios a reproducirse. Sin embargo se necesita una muestra mayor para confirmar estos datos. Los resultados sugieren que el tamaño de las cajas no tiene efecto en la reproducción de las aves y que estas no tienen preferencia por un tamaño particular.

Numerous designs have been published for Eastern Bluebird (*Sialia sialis*) nest boxes (see Kibler 1969 for review). One aspect of the designs that remains controversial is floor size. Some writers (e.g., Varner 1964) have advocated nest boxes with a floor size not greater than 10.1 cm × 10.1 cm; others (e.g., Laskey 1940) recommended floor sizes of at least 12.7 cm × 12.7 cm. Since floor size influences clutch size and, subsequently, the number of fledglings produced in several cavity nesting species (Gustafsson and Nilsson 1985) information about optimal floor size would be useful to those involved in bluebird management. I report the first systematic comparison of reproductive success of Eastern Bluebirds nesting on the same study area in different sized nest boxes.

TABLE 1. Number of Eastern Bluebird nests at sites with a large and a small nest box.[a]

Site no.	Number of nests	
	Large box	Small box
3	1	7
11	7	3
30	2	4
31	5	7
32	8	3
33	10	10
42	2	5
46	4	5
55	8	0

[a] Three sites, each with a single nest in the large box, are excluded.

STUDY AREA AND METHODS

From 1969–1984 I maintained about 40 Eastern Bluebird nest boxes in farmland of Obion County, Tennessee. A description of the area and climate is given by Pitts (1976). In March 1977, I installed 10 pairs of nest boxes on the area. Each pair consisted of a large box with a floor size of 143 cm^2 and a small box with a floor size of 71.5 cm^2. In other respects the boxes were identical. Entrances were 3.8 cm in diameter; the bottom of each entrance was 13.3 cm above the floor. All boxes were constructed of 2 cm thick redwood lumber. A small box and a large box were attached to opposite ends of two 75 cm long horizontal supports on a metal post at each site. Entrances of each pair were the same height and faced the same direction. At half of the sites, the small box was on the left and the large box was on the right; positions were reversed on the other pairs. Nest boxes were monitored at least once per week during the nesting season. The distance from the top of each nest to the bottom of the box entrance was measured early in incubation; since the internal dimensions of the nest boxes were known, this measurement allowed calculation of nest height and volume.

All nestlings and adults were banded with U.S. Fish and Wildlife Service bands. Adults were also uniquely marked with colored, plastic leg bands. Ages of adults not reared on the study area were determined by examination of tenth primary coverts (Pitts 1985). This technique allows separation of yearlings (second-year or SY) from older (after-second-year or ASY) adults; it does not allow recognition of different age classes within the ASY age group. Nesting material and debris were removed from boxes following each nesting attempt. Data from 1977–1984 are used here. Many bluebirds on the study area have three nests/yr. First nests are considered to be from mid-March through 30 Apr.; second nests are from 1 May through 22 Jun.; and third nests are from 23 Jun. through September (Pitts 1976). Statistical tests were considered to be significant if $P < 0.05$; the equality of percentages was tested by arcsine transformation (Sokal and Rohlf 1969, p. 607).

TABLE 2. Comparison of Eastern Bluebird nests in large and small nest boxes (sample sizes in parentheses).

	Large boxes	Small boxes	*P*
Mean nest volume (cm^3)	64.2 (49)	28.8 (42)	<0.0001
Mean nest height (cm)	7.3 (49)	6.3 (42)	0.0011
Mean clutch size	4.6 (49)	4.7 (42)	NS
% eggs hatching	83.4 (223)	82.1 (196)	NS
No. young fledged/nesting attempt	2.9 (50)	3.0 (44)	NS
No. young fledged/successful nest	4.0 (36)	4.3 (31)	NS
% nests successful	72.0 (50)	70.5 (44)	NS
% of fledglings returning to nest	8.7 (11)	3.2 (5)	0.04

RESULTS AND DISCUSSION

The bluebird population on the study area declined from 30 pairs in 1976 to 3 pairs in 1979 due to adverse winter weather (Pitts 1981). Not only did this population decline result in fewer nests than anticipated in the experimental boxes, it may have also affected the movements of bluebirds since the survivors had many vacant territories and nest boxes from which to select. Bluebirds constructed 94 nests in the paired boxes. At no time were both boxes of a pair used simultaneously by bluebirds; on one occasion a pair of Carolina Chickadees (*Parus carolinensis*) occupied the small box while bluebirds used the large box. Fifty nests were in large boxes and 44 were in small boxes. Overall, neither box size was preferred ($\chi^2 = 0.38$, df = 1, $P = 0.5$); however, at some sites one box was consistently used (Table 1). A comparison of the initiation dates of all clutches (small boxes: $\bar{x}$ = 18 May, SD = 38.1; large boxes: $\bar{x}$ = 5 Jun., SD = 36.0) indicates the peak of small box use occurred earlier than the peak of large box use ($t = 2.39$, df = 92, $P = 0.019$).

A comparison of nests in large and small boxes is given in Table 2. Nests in large boxes were significantly larger than nests in small boxes ($t = -16.12$, df = 89, $P < 0.0001$). Nests in large boxes were also taller ($t = 3.38$, df = 89, $P = 0.0011$). Neither nest size nor nest height was related to the time of year when the nest was constructed ($r^2 = 0.0$ for nest size and nest height in both large and small boxes when correlated with egg laying dates). The slight difference in clutch sizes (Table 2) is not significant and probably is due to the greater number of nests built in small boxes early in the season when clutches are larger (Pitts 1976). The percentage of eggs hatching did not differ significantly between the two box sizes (Table 2). Nests in large boxes fledged fewer young per nesting attempt (nests in which at least one egg was laid), but the difference is not significant (Table 2). Successful nests (those nests producing at least one fledgling) in small boxes fledged a slightly larger number of young, but again the results do not differ significantly (Table 2). The percentage of successful nests did not differ significantly between the box sizes (Table 2). The small number of nests that did not produce any

TABLE 3. Number, date of initiation, and size of Eastern Bluebird clutches in large and small boxes during each of the three annual nesting periods.

Nesting period	No. of nests		Mean date of Clutch initiation		Mean clutch size	
	Large	Small	Large	Small	Large	Small
1	12	18	9 Apr.	10 Apr.	5.2	5.1
2	21	17	5 Jun.	31 May	4.5	4.5
3	17	9	15 Jul.	7 Jul.	4.2	4.2

fledglings (14 in large boxes, 13 in small boxes) failed for a variety of reasons. No single cause of failure was associated with either box size. The number of young that returned to the study area to nest was significantly greater from large boxes ($\chi^2 = 6.08$, df = 1, $P = 0.04$) than small boxes. Due to the small sample size, I believe it would be premature to conclude that large boxes are more productive than small boxes. However, since the number of young surviving to reproduce is the best indicator of nest success, the data should be interpreted as indicating that this aspect is worthy of additional study. In this respect, weights of nestlings near the time of fledging would be useful since other studies (e.g., Lack 1966) have demonstrated that heavier fledglings have a greater probability of surviving.

A comparison of nests within each of the three nest periods (Table 3) indicates that neither box size was preferred; however, the trend toward use of small boxes early in the season and large boxes later in the season, while not significant, suggests that larger sample sizes are needed to clearly determine if bluebirds have a seasonal preference for a particular box size. Dates of clutch initiation did not differ in the two box sizes during the different nesting periods (Period 1: $t = -0.29$, df = 28, $P = 0.77$; Period 2: $t = -1.61$, df = 36, $P = 0.12$; Period 3: $t = -1.41$, df = 24, $P = 0.17$). Neither did mean clutch sizes differ between the box sizes (Period 1: $t = -0.69$, df = 27, $P = 0.49$; Period 2: $t = 0.00$, df = 34, $P = 1.0$; Period 3: $t = 0.17$, df = 24, $P = 0.87$).

Second-year females used 18 large boxes and 12 small boxes ($\chi^2 = 1.2$, df = 1, $P = 0.26$); ASY females used 21 large boxes and 19 small boxes ($\chi^2 = 0.10$, df = 1, $P = 0.76$). Although small sample sizes during each nesting period (Table 4) preclude statistical tests, the data suggest that neither age class preferred either size of nest box.

Females were identified at 37 (84.1%) of the nests in small boxes and at 48 (96.0%) of the nests in large boxes. Thirty-seven different females were recognized; at initial capture 23 were SY, 6 were ASY, and the other 8 were of unknown age. Eight females (21.6%) nested more than one year in the large-small boxes; however, several other females used additional boxes on the study area. Nineteen females had only one nest in large-small boxes and seven had two nests; the other 11 females had

TABLE 4. Use of large and small boxes by SY and ASY female Eastern Bluebirds.[a]

	SY		ASY	
Nesting period	Large	Small	Large	Small
1	4	6	7	8
2	8	4	8	7
3	6	2	6	4

[a] Nests (n = 24) where the age of the female was not known are excluded.

3–9 nests each. Of the 18 females that had more than one nest, five used only large boxes, three used only small boxes, and 10 used both large and small boxes. Sixteen females initially chose large boxes while 21 chose small boxes ($\chi^2 = 0.68$, df = 1, $P = 0.37$). Second-year females did not show an initial preference for box size; of 23 SY females, 10 initially selected large and 13 selected small boxes ($\chi^2 = 0.39$, df = 1, $P = 0.50$). The number of ASY females was too small to indicate a preference; one of six initially chose a large box and the other five initially used small boxes.

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