Use of Artificial Nest Cavities Along Ohio Interstate Highways by Bluebirds (*Sialia sialis*) and Mice (*Peromyscus* sp.)[1]

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ABSTRACT. Populations of eastern bluebirds in Ohio have declined. A construction project using drilled highway fence posts as nest cavities was established to increase nesting potential. These cavities were investigated to determine the degree of utilization and identify favorable habitat characteristics for nesting bluebirds. Of 296 cavities examined in 1985 on I-71 north and I-70 east of Columbus, six (2%) were occupied by bluebirds during June–July. Fourteen of 374 (3.7%) nest cavities were occupied by bluebirds in 1986. Most nests were found along I-71 north. House wrens (*Troglodytes aedon*), house sparrows (*Passer domesticus*), and Carolina chickadees (*Parus carolinensis*) also nested in these cavities. *Peromyscus* sp. nests increased from 118 cavities (40%) in 1985 to 234 (62.6%) in 1986. In 1986, mice occupied 91% of the nest cavities along I-70 west of Dayton, 88% of the cavities on I-71 north of Columbus, and over half of the other cavities examined. Nest cavities surrounded by vegetation and cropfield were more likely to be occupied by mice. The number of empty cavities decreased from 52% in 1985 to 24.9% in 1986. Approximately 7.8% of the cavities were rotten; 16.3% were too shallow to be used by birds. Management of these nest cavities is very important. They should be maintained in good condition and mice should be excluded to improve their use by bluebirds.

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INTRODUCTION

Bluebird populations have declined for the past decade (Peakall 1970). Von Haartman (1957) indicated that the number of nesting holes probably acts as an ecological limiting factor for hole-nesting birds. This limitation in the number of available nesting cavities is thought to be a major factor limiting populations of several secondary cavity-nesters, including eastern bluebirds (Pinkowski 1979a, Willner et al. 1983). Eastern bluebirds nest in tree cavities (Pinkowski 1976, 1977a) and nest boxes (Kibler 1969). Although their selection of natural or artificial cavities is influenced by age and previous nesting success (Pinkowski 1979b), populations can be increased by providing nest boxes (Eakin 1983).

In order to increase bluebird populations in Ohio, a bluebird nest cavity construction project was initiated by the Ohio Division of Wildlife's Non-Game and Endangered Wildlife Program. The purpose of this study was to evaluate the degree of wooden fence post cavity use and to find the habitat characteristics favorable for nesting bluebirds.

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MATERIALS AND METHODS

The incidence of breeding bird use of cavities was determined by examining the fence post cavities along highways in the vicinity of Dayton, Columbus, Cincinnati, Canton and Zanesville, Ohio during June–July, 1985 and March–July, 1986. Data were collected from five interstate highway surveys each year: 1) I-71 north of I-270 from Columbus to Bellville; 2) I-71 south of Xenia to I-275 north of Cincinnati; 3) I-70 west from Dayton to the Indiana border; 4) I-77 north from Strasburg to Canton; and 5) I-70 east from Buckeye Lake to Cambridge. In addition, 140 nest cavities on I-71 north were intensively examined three times in 1986 to test the effect of removing mouse nests prior to the bluebird breeding season.

Information concerning habitat types and nest cavity properties was collected and analyzed quantitatively only in 1985. Twenty-three variables, modified from Willner et al. (1983) and Munro and Rounds (1985), were evaluated at each bluebird nest and every second cavity. The following cavity measurements and habitat characteristics were recorded: 1) depth from the bottom of entrance hole to floor of the cavity (DPTH); 2) height of entrance hole above ground (HIGH); (3) distance to

nearest tree or large perch (≥ 2 m in height; DNTR); 4) distance to nearest tree or large perch (≥ 2 m in height) in front of cavity (area within 180° arc of cavity front; DNTRF); 5) distance to nearest shrub or small perch (<2 m in height; DNSP); 6) distance to nearest shrub or small perch (<2 m in height) in front of cavity (DNSPF); 7) height of nearest tree or large perch (HDNTR); 8) height of nearest tree or large perch in front of cavity (HDNTRF); 9) height of nearest shrub or small perch (HDNSP); 10) height of nearest shrub or small perch in front of cavity (HDNSPF); 11) distance to the vegetation above the entrance hole (ABV); 12) distance to the vegetation below the entrance hole (BEV); and 13–20) the percent coverage of habitat types recorded within a 50-m radius of each nest cavity excluding the highway surface. Habitat types included annuals, woody area, shrubby area, grass, water, tall grass, fallow field, and cropfield.

Because bluebird nest sample size was too small to use discriminant function analysis, the student *t*-test (Sokal and Rohlf 1969) was used to analyze the differences in site characteristics among bluebirds, mice, and empty cavities. Other variables recorded included: 21) entrance hole aspect relative to the highway (HHDIR); 22) the direction of orientation of entrance hole (DIRH); and 23) the presence or absence of livestock, human disturbance and utility lines (DISTU). A chi-square test was used to analyze these three variables.

RESULTS

In 1986, bluebirds used more than twice the number of nest cavities as in 1985. Six of 296 fence cavities were occupied by bluebirds in 1985 and 14 of 374 in 1986. I-71 north and I-70 east of Columbus had more bluebird nests than cavities along other interstate highways examined. In 1985, three bluebird nests were found along I-71 north in late June: one with five nestlings, one with one dead nestling, and another with three eggs. The other three nests, examined in early July, were found along I-70 east, and contained five eggs, five nestlings, and four nestlings. In 1986, 10 bluebird nests with eggs or nestlings were found along I-71 north; five of these probably continued to have the second clutch because they occupied the same nest cavities. In addition, three nests were found along I-70 east and one on I-77 north.

Many cavities contained *Peromyscus* sp., wasp, ants, and competing cavity nesters such as house sparrows (*Passer domesticus*), house wrens (*Troglodytes asdon*) and chickadees (*Parus carolinensis*). *Peromyscus* use increased from 40% ($N = 296$) of all cavities examined in 1985 to 62.6% ($N = 374$) in 1986. They were found using these cavities in winter, spring, and summer. In 1986, mice occupied 91% of the nest cavities on I-70 west of Dayton and 88% of those along I-71 north of Columbus, and over half the cavities checked along the other three highways. Only one house wren and one chickadee nest were found with eggs or juveniles in 1985. In 1986, we found two house sparrow, one house wren, and four chickadee nests. Fourteen to 17 cavities containing nest materials were used by unknown species of birds. The number of empty cavities decreased from 52% to 24.9% during these two years.

The highest use of nest cavities by bluebirds in 1986 occurred on I-71 north where *Peromyscus* nests were removed prior to the bluebird breeding season in early March. Nine bluebird nests were found in May, 1986, but only three were found in June, 1985. Without removing mouse nests prior to the bluebird breeding season along I-70, the same number of bluebirds nests was observed both years. Although we have no direct evidence that *Peromyscus* and bluebirds competed directly for the nest cavities, mouse nest material was found on top of a bluebird nest in one cavity. Some *Peromyscus* returned to nest cavities after nest removal; some built new nests by mid-summer. Without predator guards, the predation rate was high in these cavities. Predation occurred in three of nine bluebird nests, and raccoon (*Procyon lotor*) tracks were found on one of the cavity posts where predation occurred.

A comparison of the characteristics of nests and habitat among bluebirds, *Peromyscus*, and empty cavities is listed in Table 1. The *t*-test revealed no significant difference between nest sites used by bluebirds and by *Peromyscus* for all characteristics of nest and nest habitat, except the presence of cropfield ($t = -6.47$, df = 60, $P < 0.001$). The average distance of a used nest cavity to the nearest perch was 4.26 m to a tree and 3.9 m to a shrub for bluebirds. These distances were less than those for *Peromyscus* and empty cavities. However, the average distance of used nest cavities to the nearest shrub in front of the hole was smallest for *Peromyscus* and largest for bluebirds. The nests of mice were usually close to vegetation in front of the hole; the nests of bluebirds were close to perches near the back of the entrance hole.

The average depth of the nest cavities used by bluebirds was 7.7 cm (range = 5–10 cm). Wooden fence cavities with depths less than 5 cm were regarded as too shallow. We found that 16.3% of the nest cavities were too shallow, and that 7.8% were rotten and not suitable for bluebird use.

Although many cavity openings faced toward north and east ($P < 0.05$), the entrance hole aspect relative to the highway were random for bluebirds ($X^2 = 0.67$, $P > 0.05$) and mice ($X^2 = 1.79$, $P > 0.05$). However, empty cavities faced toward the highway more often ($X^2 = 3.37$, $P < 0.05$). Thirty-three percent of bluebird nest cavities, 57% of the mouse nests, and 67% of empty cavities were close to human disturbance and utility lines, but no preference was noted ($X^2 = 1.92, 0.33, 0.64$, respectively; $P > 0.05$).

DISCUSSION

In 1985 and 1986, 2% and 3.7%, respectively, of the nest cavities were used by eastern bluebirds. Some cavities were too shallow to be occupied. Pinkowski (1976) indicated that the minimum depth for 110 natural cavity nests of eastern bluebirds was 7.6 cm. Kibler (1969) suggested that if cavities are too shallow they may cause high predation, especially without predator guards. He also suggested that the distance from the bottom of the entrance hole to the floor should be 20 cm.

The potential predators of bluebirds include raccoon, domestic cat (*Felis domesticus*), opossums (*Didelphis vir-*

TABLE 1
Comparison of the characteristics and habitat of nests among bluebirds, Peromyscus, *and empty cavities. Data were collected between June–July, 1985, in Ohio.*

	Bluebirds (N = 6)		*Peromyscus* (N = 56)		Empty cavities (N = 76)	
Variables	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
DPTH(cm)	7.70	1.90	7.70	4.20	8.70	4.00
HIGH(m)	1.36	0.08	1.31	0.11	1.32	0.10
DNTR(m)	4.26	2.61	8.41	9.02	10.50	10.55
HDNTR(m)	5.50	2.30	6.37	8.29	5.62	4.67
DNTRF(m)	14.24	11.57	9.02	9.05	12.44	12.10
HDNTRF(m)	4.85	3.16	7.08	9.17	5.86	4.17
DNSP(m)	3.90	3.48	4.36	5.96	4.98	6.12
HDNSP(m)	1.20	0.46	1.39	0.65	1.26	0.40
DNSPF(m)	6.11	6.13	4.81	5.86	5.97	7.43
HDNSPF(m)	1.22	0.33	1.33	0.51	1.56	1.45
ABV(m)	0.39	0.36	0.48	0.32	0.56	0.31
BEV(m)	1.06	0.09	1.04	1.12	0.71	0.60
Annuals(%)	24.16	19.34	24.84	17.22	25.46	16.50
Woody area(%)	7.50	6.89	9.43	14.00	8.62	14.10
Shrub area(%)	5.00	5.48	8.44	6.93	7.54	6.40
Grass(%)	20.80	17.15	15.00	9.35	17.54	15.57
Water(%)	9.17	22.45	1.39	2.40	2.08	4.41
Tall grass(%)	28.33	16.02	22.54	14.30	24.77	18.00
Fallow(%)	5.00	7.75	2.05	6.90	0.85	3.40
Cropfield(%)	0.00	0.00	16.39	19.80	13.15	18.10

giniana), and snakes (Pinkowski 1976). Red squirrels (*Tamiasciurus hudsonicus*) and deer mice (*Peromyscus* sp.) are known predators and nest cavity competitors (Kibler 1969). Paper wasps (*Polistes* sp.) and ants may also use the cavities. Fence cavities without predator guards may allow high predation, especially after human checks of these cavities. Without frequent maintenance these cavities are used more often by mice.

The presence of perches (Pinkowski 1978) and specific ground-cover characteristics are very important to bluebird use of cavities (Munro and Rounds 1985). In the present study, eastern bluebirds used nest sites with the greatest availability of grass and sparse ground cover which is advantageous for feeding (Pinkowski 1974, 1977b, 1979c). Densely overgrown areas and areas devoid of trees and shrubs normally are avoided by eastern bluebirds (Connor and Adkisson 1974).

Other birds used cavities on these bluebird trails, including house sparrows, house wrens, and chickadees. Tree swallows (*Tachycineta bicolor*), house wrens, and house sparrows have been reported to frequently use nest-trail cavities (Munro and Rounds 1985). House sparrows prefer the largest internal area, smallest entrance-hole diameter, and nests that are higher above ground and closer to buildings than those used by bluebirds (Munro and Rounds 1985). In the present study, buildings were at least 50 m away from nest cavities; therefore, the probability of these cavities being occupied by sparrows or swallows was not high.

MANAGEMENT IMPLICATIONS

Placement of nest cavities or boxes is very important for bluebirds. Munro and Rounds (1985) indicated that nest cavities should be placed at least 400 m away from farmsteads or buildings because house sparrows prefer these sites. Nest boxes should be placed in open wooded pasture away from roads and utility lines. Once established, trails should be maintained for at least 10 years to allow establishment of local populations. Kibler (1969) suggested that nest boxes be cleaned out after nesting and that the holes be closed in autumn and opened by the first week in March to prevent use by mice and squirrels.

We offer some management suggestions for each interstate highway area:

I-71 north — This appears to offer the best habitat but there is a presistent problem with *Peromyscus*. Management of the cavities on this stretch of highway would probably substantially increase use by bluebirds. Management should include repair of cavities and removal of *Peromyscus* nests in early spring.

I-71 south — Habitat seems suitable for bluebirds but use by *Peromyscus* is very high. Management should substantially increase use once bluebirds become accustomed to using these nest cavities.

I-70 west — The nest cavities located here are in very poor habitat due to extensive farming in this region. Use by *Peromyscus* is also very high. Management of this area is not recommended.

I-70 east — Habitat in this area is marginal. However, roadside rest areas appear to offer good habitat. Management may increase use by bluebirds.

I-77 north — This stretch of highway offers the second best habitat. *Peromyscus* use is a concern; management should increase use by bluebirds.

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LITERATURE CITED

Connor, R. N. and C. S. Adkisson 1974 Eastern bluebirds nesting in clearcuts. J. Wildl. Manage. 38: 934-935.

Eakin, J. 1983 A study of the eastern bluebird at the Holden Arboretum, Lake County, Ohio. Kirtlandia 40: 1-51.

Kibler, L. F. 1969 The establishment and maintenance of a bluebird nest-box project. A review and commentary. Bird-Banding 40: 114-129.

Munro, H. L. and R. C. Rounds 1985 Selection of artificial nest sites by five sympatric passerines. J. Wildl. Manage. 49: 264-276.

Peakall, D. B. 1970 The eastern bluebird: its breeding season, clutch size and nesting success. Living Bird 9: 239-256.

Pinkowski, B. C. 1974 A comparative study of the behavioral and breeding ecology of the eastern bluebirds (*Sialia sialis*). Detroit, MI: Wayne State Univ. Dissertation.

——— 1976 Use of tree cavities by nesting eastern bluebirds. J. Wildl. Manage. 40: 556-563.

——— 1977a Breeding adaptations in the eastern bluebird. Condor 79: 289-302.

——— 1977b Foraging behavior of the eastern bluebird. Wilson Bull. 89: 404-414.

——— 1978 Feeding of nestlings and fledgling eastern bluebirds. Wilson Bull. 90: 84-98.

——— 1979a Annual productivity and its measurements in a multibrooded passserine, the eastern bluebird. Auk 96: 562-572.

——— 1979b Nest site selection in eastern bluebirds *Sialia sialis*. Condor 81: 435-436.

——— 1979c Foraging ecology and habitat utilization in the genus *Sialia*. *In:* J. G. Dickison et al. (eds.), The role of insectivorous birds in forest ecosystems. New York: Academic Press; pp. 165-190.

Sokal, R. R. and F. J. Rohlf 1969 Biometry: the principles and practice of statistics in biological research. San Francisco: W. H. Freeman and Co.

von Haartman, L. 1957 Adaptation in hole-nesting birds. Evolution 11: 339-347.

Willner, G. R., J. E. Gates and W. J. Devlin 1983 Nest box use by cavity-nesting birds. Am. Midl. Natur. 109: 194-201.