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IF YOU BUILD THEM, THEY WILL COME: NEST BOXES INCREASE EASTERN BLUEBIRD RECRUITMENT WITHIN A SITE IN NORTHWEST GEORGIA

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Introduction

Eastern Bluebirds (*Sialia sialis*) are distributed throughout most of eastern North America and parts of Mexico and Central America (Gowaty and Plissner 1998). They are found commonly throughout Georgia with confirmed reports of breeding activity in nearly every county (Wigh 2010). These easily recognizable thrushes inhabit open grassy areas such as pastures and fields, orchards, recent clear-cuts or burned tracts, pine savannas and large lawns that provide foraging areas, perching sites, insect prey, and nesting sites (Gowaty and Plissner 1998). Eastern Bluebirds form monogamous pair bonds during the breeding season, but extra-pair paternity occurs with some regularity (Gowaty and Bridges 1991). As secondary-cavity nesters, they require snags, partially rotted fence posts, or other structures supporting existing cavities (Gowaty and Plissner 1998). Pairs may produce up to 5 broods per season, although 2 successful broods are typical (Gowaty and Plissner 1998).

Eastern Bluebird populations have exhibited moderate increases and sometimes drastic decreases since the early 1900s (Robbins et al. 1986, Sauer and Droege 1990). Potential causes of these population reductions include loss

of habitat and nesting sites due to urbanization, agricultural intensification, conversion of farmland to pine plantations, and competition with other cavity-nesting species, as well as increased pesticide use and severe climatic events (Robbins et al. 1986, Sauer and Droege 1990). Beginning in 1978, Breeding Bird Survey (BBS) data indicated that Eastern Bluebird populations rebounded over the following 10-year period with no U.S. state experiencing significant losses (Sauer and Droege 1990). Efforts by conservation groups, such as the North American Bluebird Society, contributed to this recovery in many areas with the use of nest boxes (North American Bluebird Society 2005). Data from the BBS indicate continued increases in Eastern Bluebird numbers through 2010, including a 2.8% increase in Georgia (Sauer et al. 2011).

Floyd County in northwest Georgia is home to Berry College, the world's largest college campus (Berry College 2010). Within its more than 10,000 ha in land holdings, approximately 1200 ha provide suitable bluebird habitat consisting of extensive lawns, Bermuda grass (*Cynodon* spp.) fields used for hay production, and mixed-grass pastures supporting the college's beef and dairy operations and equine facility. Despite the abundance of foraging habitat, our general impression was that there were fewer bluebirds present than would be expected during the summer and fall of 2001, and we suspected that the population could be experiencing recruitment problems. Our objectives in this study included quantifying the productivity of this bluebird population and qualifying factors that might be impeding recruitment, such as a lack of suitable nesting substrates. We hypothesized that the installation of nest boxes would increase recruitment.

Methods

Initial Census and Breeding Survey

From April through June of 2002, we conducted biweekly surveys by driving along paved and dirt or gravel roads adjacent to or transecting pastures, fields, and lawns. Individuals and apparent bonded pairs perched in trees or on electric power transmission lines were counted and the specific location of each bluebird observed was recorded. We then observed each bird's activities for 10 min. If the bird flew from the original location, we followed it using binoculars until it took a new perch. Activity, such as carrying nesting material or an insect to a different location, entry into a potential cavity, or pair bonding rituals was noted as evidence of possible breeding. We also recorded presence of potential nesting sites (i.e., obvious cavities) and whether these sites were natural or some form of man-made structure.

Nest Box Placement and Subsequent Monitoring

Permission to erect nest boxes on power line poles, fence posts, and 4 mature loblolly pine trees (*Pinus taeda*) was granted by the Environmental Land Management Committee of Berry College. Using a North American Bluebird Society nest box design (North American Bluebird Society 2002), we constructed 50 nest boxes made of White Pine (*Pinus strobus*) planks. The hinged-lid design allowed for easy visualization of nest contents without disturbing the integrity of the nest. In December of 2002, we placed the nest boxes in areas where bluebirds were observed previously or where the habitat was appropriate and structures for mounting the boxes were present. Nest boxes were mounted on power line poles so that the entrance hole was 1.8 m from the ground. In areas without power line poles, boxes were mounted on fence posts as high as possible from the ground or 1.8 m from the ground if mounted on a tree. All boxes were separated by a minimum distance of 150 m. Because of the necessity to minimize obstructions around the poles or posts, no cone-shaped predator guards could be used. Cage-type predator guards were added to boxes where raccoon (*Procyon lotor*) activity was observed.

Based on typical Eastern Bluebird breeding patterns in the Southeast (Gowaty and Plissner 1998), in 2003 we began monitoring each nest box on a weekly basis beginning on 15 February and continuing through mid-August. Each instance of active nesting was assigned a nesting attempt (NA) identification when an eighth or more of a nest was constructed inside the nest box. We began monitoring each nest biweekly once it was completed, then daily after the first egg was laid and until the clutch was completed. The number of eggs comprising the clutch was recorded along with the date on which the last egg was laid. After an incubation period of 12 days, we began checking the nest box daily for hatching and for 3 additional days after the first nestling hatched to determine the number of eggs that hatched. On day 10 post-hatching, we checked the nest box again and counted the number of nestlings present. To determine the fledge date, we began checking the nest box daily on day 15 post-hatching for nestlings until all had fledged. If all eggs or nestlings were missing on scheduled box checks, the clutch was denoted as lost to predation. Once a clutch fledged or if it was depredated, nesting material was removed from the box and it was monitored again for another clutch. We also began capturing adults in their nest boxes in 2003 as part of a health assessment study. However, no birds were banded that year.

An additional 25 nest boxes were constructed and placed before the breeding season of 2004. During the course of the study, a few of the original

boxes were moved to other locations because of recurring predation or non-use or were damaged beyond repair by cattle. We monitored all nest boxes and clutches following the previously established protocol for the breeding seasons of 2004 through 2006. In 2004, one of the authors (REC) began banding adults and nestlings in order to document subsequent nesting, recruitment, and long-term survival. The adults were captured using a trip-trap device when they entered the nest box to feed their nestlings. Nestlings were banded at day 10 post-hatch.

Reproductive data were compared among years using a repeated-measures MANOVA, and significant differences were further explored using Tukey's Honestly Significant Difference tests or contrasts. JMP-IN Statistical Software (SAS Institute, Inc. Cary, NC) was used for analyses with *a-priori* significance set at $\alpha = 0.05$.

Results

Initial Nest Monitoring and Census

In 2002, we documented 5 pairs of bluebirds exhibiting nesting activity. Four of the 5 pairs nested in dilapidated boxes that had been mounted on power line poles by an unknown individual several years prior. The fifth pair nested in a natural cavity within a large oak tree bordering a hayfield. We also observed a sixth pair unsuccessfully attempt to usurp a resident pair from their nest box. The design of the old nest boxes precluded direct visualization of eggs or nestlings, but we observed adults carrying insects to the boxes and removing fecal sacs on multiple occasions. We counted a total of 31 bluebirds, including the 6 breeding pairs, 11 apparently unpaired adult bluebirds (4 females, 7 males), and 8 juveniles during the course of the 2002 breeding season. With the exception of the existing old nest boxes and the aforementioned oak tree, no other nesting sites were located within the areas surveyed. It is possible that a few birds found nesting cavities in some of the wooded areas on the property we did not survey.

Subsequent Nest Box Use and Nesting Success

The number of nest boxes available for nesting varied somewhat year by year (Table 1). Over the course of 4 breeding seasons, most nest boxes hosting nests that produced at least one clutch (78) also hosted a second clutch (106) and occasionally a third clutch (29). Because adults could not be recaptured on

every nesting attempt, it was not possible to accurately determine how many clutches each pair produced. Nine nest boxes designated as a NA were never completed or were completed but never contained eggs. The number of eggs produced per nesting attempt differed among years ($F_{3,33}$ = 6.83, P = 0.001), as did the number of eggs hatched ($F_{3,33}$ = 5.29, P = 0.004) and number of nestlings fledged ($F_{3,33}$ = 3.52, P = 0.02) (Table 1). With the exception of 2005, the percentages of successful NAs were fairly consistent (Table 1). Over the course of the study, 80 clutches were depredated by Gray Rat Snakes (*Elaphe obsoleta spiloides*) (37), Raccoons (5), or other suspected predators (38) such as Red Imported Fire Ants (*Solenopsis invicta*), American Crows (*Corvus brachyrhynchos*), Gray Squirrels (*Sciurus carolinensis*), or Southern Flying Squirrels (*Glaucomys volans*), based on presence of the predator within the nest or condition of the empty nest. More clutches were depredated in 2005 and 2006 (27 and 26, respectively) than in 2003 and 2004 (10 and 21, respectively). Other causes of nest failure included abandonment, nest box damage or destruction, and take-over of the nest by other bluebirds or Tree Swallows (*Tachycineta bicolor*), Carolina Chickadees (*Poecile carolinensis*), House Sparrows (*Passer domesticus*), and Brown-headed Nuthatches (*Sitta pusilla*). With the exception of House Sparrows, we did not remove nests of birds other than bluebirds. Paper wasps (*Polistes* ssp.) frequently built nests under the nest box lids and had to be removed, because bluebirds would abandon a partially completed nest or not use a box inhabited by wasps.

Adult females were captured more consistently than males and therefore were used to estimate population size and recruitment of breeding-aged adults. Twenty-five adult females were captured during the first clutch cycle of 2003 (April - May). Because banding was not initiated until 2004, we do not know how many of the females captured during June and July of that year were those captured previously. Forty-one adult females were banded in 2004, the first year that birds were banded. It is likely that many of those were adult females captured in 2003, their offspring, adult females present on the site but not previously captured, or new immigrants from other areas. Numbers of newly banded adult females decreased to 21 in 2005 and 16 in 2006. Ten of 36 previously banded females captured in 2005 were banded as nestlings in 2004 and 9 of 34 captured in 2006 were banded as nestlings in 2005.

Table 1. Reproductive data for Eastern Bluebirds on the Berry College campus in Floyd County, Georgia, after placement of nest boxes (2003-2006).

REPRODUCTIVE DATA								
Year	**Available nest boxes**	**NA[1]**	**Eggs laid**	**First egg date**	**Eggs hatched**	**Nestlings fledged**	**Last fledge date**	**Successful NA (%)[2]**
2003	50	83	304	24 March	246	201	25 August	58 (69.8)
2004	75	98	425	26 March	316	254	22 August	68 (69.3)
2005	67	117	432	30 March	322	238	18 August	67 (57.2)
2006	65	112	452	16 March	320	254	12 August	77 (68.7)
Total		410	1613		1204	947		270 (65.8)

[1]NA = Nesting attempt by a bluebird, assigned when a nest was at least one-eighth completed.
[2]Successful = At least one nestling fledged.

Discussion

Placement of nest boxes successfully increased Eastern Bluebird recruitment to the study site. Apparently, the lack of both natural and artificial nesting sites substantially suppressed productivity, which in turn decreased recruitment of additional breeding birds into the population each year. Nesting success after the placement of nest boxes (65.8% overall), as measured by the percentage of successful individual nesting attempts, is within the range expected for Eastern Bluebirds (55-84%) (Gowaty and Plissner 1998) and similar to that reported from a study in Virginia (59-65%) (LeClerc et al. 2005). It is possible that nesting success and recruitment would have been greater if every nest box had been used exclusively by bluebirds, rather than some boxes being occupied by other bird species, and if predator guards had been placed on the mounting structures. Eviction of bluebirds from nest boxes by competing species is not unusual. In one study, Tree Swallows successfully displaced Eastern Bluebirds from nesting substrates in nearly one-fourth of monitored territories (Meek and Robertson 1994).

There was a decrease in reproductive success during 2005, but nesting success rebounded in the following year. Above normal precipitation (+ 1.75 cm) occurred during April of 2005 (National Oceanic and Atmospheric Administration 2007) when the first nests and clutches were produced. It was the wettest April during the study. We observed that female bluebirds delayed nest construction when available nesting materials were wet. Less than normal precipitation (-4.65 cm) followed in May (National Oceanic and

Atmospheric Administration 2007), when first broods would have normally fledged. Departure from the normal weather pattern during the early breeding season may have been a causal factor for the lower reproductive success in 2005. Reduced rainfall during the month of May could have diminished the abundance of available insects, the primary food for fledglings.

Eastern Bluebirds are currently listed as a species of least concern (International Union on Conservation of Nature 2011). However, as demonstrated here, recruitment of breeding adults into local populations may be impeded due to a lack of nesting sites. Nest boxes provide suitable replacements for natural cavities and can increase recruitment rates of breeding adults into local populations. The installation of nest boxes should be considered as part of a management plan when attracting bluebirds to a suitable habitat or increasing their recruitment rate is desired.

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