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Using Science to Benefit Golf

Researchers at Davidson College (North Carolina) investigated nest-site competition between Brown-headed Nuthatches (shown above) and Eastern Bluebirds and tested management strategies to enhance nuthatch numbers on southeastern golf courses. The research demonstrates that nest box programs can help bolster declining nuthatch populations if the size of the nest box entry holes are reduced to exclude competing bluebirds.

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PURPOSE

The purpose of *USGA Turfgrass and Environmental Research Online* is to effectively communicate the results of research projects funded under USGA's Turfgrass and Environmental Research Program to all who can benefit from such knowledge. Since 1983, the USGA has funded more than 400 projects at a cost of $31 million. The private, non-profit research program provides funding opportunities to university faculty interested in working on environmental and turf management problems affecting golf courses. The outstanding playing conditions of today's golf courses are a direct result of ***using science to benefit golf***.

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Bluebird-proof Nest Boxes Increase Brown-headed Nuthatch Breeding on Southeastern Golf Courses

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SUMMARY

Brown-headed Nuthatches (*Sitta pusilla*) have suffered population declines throughout their range in the southeastern United States. Researchers investigated nest site competition between these nuthatches and Eastern Bluebirds (*Sialia sialis*) and tested management strategies to enhance nuthatch numbers on southeastern golf courses. Findings include:

- Numbers of nesting nuthatches increased dramatically when bluebirds were excluded from boxes by reducing the size of entrance holes.
- Although Brown-headed Nuthatches are assumed to be pine-dependent, local pine densities had no significant influence on where they nested. Rather, nuthatches nested almost exclusively in nest boxes where bluebirds were excluded.
- When we returned bluebird-accessible entrance holes to nest boxes, bluebirds usurped nearly all nuthatch nests, demonstrating not only that nuthatches are not averse to using standard boxes, but also that bluebirds can actively displace nesting nuthatches.
- To test whether pairing standard boxes would allow for both species to coexist, we compared nuthatch occupancy of standard box pairs (both boxes with bluebird-accessible holes) vs. pairs consisting of one bluebird-accessible box and one bluebird-proof box). Bluebird/nuthatch coexistence was significantly greater in the latter pair type, suggesting that when standard boxes are paired, bluebirds defend both boxes – even though they use only one.
- Because pairing standard boxes provides no benefits to nuthatches, we recommend that southeastern golf courses simply provide every other nest box with a one-inch (bluebird-proof) entrance hole.

The use of nest boxes to maintain or increase the size of target populations is well-established. Where natural cavities are limited in number, species often respond dramatically to the addition of nest boxes to habitats (28). In North America, artificial nesting structures have been used to increase numbers of both Wood Ducks (*Aix sponsa*) (14) and American Kestrels (*Falco sparvarius*) (19). But few nest box programs can match the scale and enthusiasm with which nest boxes have been made available to Eastern Bluebirds (*Sialia sialis*) (henceforth "bluebirds").

Founded in 1978, the North American Bluebird Society has facilitated nest box programs by hundreds of affiliate organizations and thousands of interested citizens. The provisioning of nest boxes starting around 1980 has undoubtedly played an important role in the "recovery" of this species (12). Breeding Bird Survey data (31) show dramatic increases since the late 1970s,

Brown-headed Nuthatch *(photograph by A. Mercadante)*.

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while Christmas Bird Count data suggest a quadrupling of numbers (27). At present, tens of thousands of nest boxes are maintained to benefit bluebirds.

Golf courses are particularly popular as sites for bluebird nest box programs (11). Moreover, recent studies indicate that the reproductive success of bluebirds nesting on golf courses is very similar to that enjoyed by bluebirds nesting in rural habitat - at least in the southeastern U.S. (6, 20, 33).

Although golf course nest box programs are often tailored to benefit bluebirds, most people assume that nest boxes promote biodiversity by benefitting multiple members of the cavity-nesting guild (11). For example, Merila and Wiggins (25) found that up to 17% of Collared Flycatchers (*Ficedula albicollis*) in a population died as a result of competitive interactions over nest sites with Great Tits (*Parus major*). However, by increasing the availability of nest boxes, competition and mortality were eventually reduced (25). Increasing nest site availability also reduced competition and promoted coexistence between Great Tits and subordinate Blue Tits (*Cyanistes caeruleus*) (9, 28).

Male Eastern Bluebird *(photograph by A. Mercadante)*.

Of course, within a local "nest web" (23), the addition of nest boxes is unlikely to similarly affect all species. For example, when Brawn and Balda (3) added large numbers of nest boxes to Ponderosa Pine (*Pinus ponderosa*) habitats in northern Arizona, Violet-green Swallows (*Tachycineta thalassina*), Western Bluebirds, (*Sialia mexicana*), and Pygmy Nuthatches (*Sitta pygmaea*) exhibited strong numerical responses; Mountain Chickadees (*Poecile gambeli*) showed an intermediate response; White-breasted Nuthatches (*Sitta carolinensis*) and House Wrens showed very little response at all. Considering the expense and effort involved in maintaining nest box programs on golf courses, the issue of their guild-wide benefits is non-trivial.

Take, for example, the Brown-headed Nuthatch (*Sitta pusilla*). This diminutive cavity-nesting cooperative breeder is historically associated with mature pine stands, particularly fire-maintained stands of mature Shortleaf (*Pinus echinata*), Loblolly (*P. taeda*), and Longleaf (*P. palustris*) Pine (8, 17, 21, 29, 32, 36). Although Brown-headed Nuthatches (hereafter "nuthatches") have managed to persevere throughout the piedmont and coastal plain from southeastern Virginia to east Texas (13, 36), their numbers have exhibited a steady decline (31). As a result, the Brown-headed Nuthatch is federally listed as a Bird of Conservation Concern, it is listed as Declining on the American Bird Conservancy Green List, and was listed as a Yellow (declining) species on the 2002 WatchList of U.S. Birds (4, 5).

Researchers generally posit that the decline of Brown-headed Nuthatches is due to "extensive logging of mature pinelands, fragmentation of habitat, and forest management practices that limit the availability of dead trees suitable for cavity excavation" (26). Although these negative impacts are indisputable, we propose that burgeoning bluebird populations may have also played a role. McNair (24) concluded that bluebirds are the primary nest site competitor for Brown-headed Nuthatches, citing both his own observations and those in the literature (1, 2, 15, 16, 29, 30) that the interactions McNair (24)

recorded took place primarily in human-altered habitats in no way detracts from our contention that bluebirds may have a negative impact on these nuthatches. Indeed, in the 21st century, most Brown-headed Nuthatch habitat will be significantly human-altered.

As a pine-associated cavity nester native to the Southeast, the Brown-headed Nuthatch would appear to be a potential beneficiary of golf course nest box programs. However, if bluebirds are able to monopolize such nest boxes, these programs cannot be said to be enhancing biodiversity in general or aiding nuthatches in particular. Consequently, we sought to determine 1) the degree to which bluebirds prevent nuthatches from utilizing golf course nest boxes, 2) the relative importance of habitat quality (pine density) and bluebird competition in predicting the use of golf course nest boxes by nuthatches, and 3) whether pairing of nest boxes promotes the coexistence of bluebirds and nuthatches.

Materials and Methods

We monitored nest boxes on seven residential golf courses near Davidson, Mecklenburg County, North Carolina from 2001 through 2011. All boxes are identical cylindrical Schwegler® woodcrete boxes with an interior diameter of 12 cm. The mean number of boxes per course from 2004 – 2008, when all boxes were unpaired, was 37.5, all of which were initially erected for bluebirds without respect to the presumed habitat preferences of nuthatches. We placed our nest boxes at a height of 1.75 meters along the edges of fairways where they would be unobtrusive to golfers and homeowners.

By the 2004 breeding season, nearly all boxes were pole-mounted with ERVA® stovepipe-style predator guards. In addition to nuthatches, other species using the nest boxes included Carolina Chickadees (*Poecile carolinensis*), House Sparrows, Tree Swallows (*Tachycineta bicolor*), Tufted Titmice (*Baeolophus bicolor*), House Wrens (*Troglodytes aedon*), and Southern Flying Squirrels (*Glaucomys volans*). We monitored every box weekly from early March through late July and removed soiled nests soon after fledging.

Question 1: Does competition with bluebirds over nest boxes prevent breeding by nuthatches?

The rarity of Brown-headed Nuthatch nests in our standard golf course nest boxes could be due to any number of factors. However, if competition with bluebirds is an important factor in keeping nuthatches out of golf course nest boxes, the elimination of bluebirds should result

Pole-mounted nest box with predator guard.

Bluebird-accessible nest box (left) and bluebird-proof nest box (right).

in a substantial increase in the number of nuthatch nests on a given course. Although the removal of bluebirds is neither ethical nor feasible, one can easily eliminate nest site competition by altering nest boxes to make them "bluebird-proof". Like most standard nest boxes, our Schwegler boxes come with an entrance hole with a diameter of 38 mm (1.5 inches). This hole size accommodates not only bluebirds, but also smaller cavity nesters, including nuthatches. By replacing these front-plates with others with a smaller 28-mm (1.1 inch) hole, we can exclude bluebirds but continue to accommodate nuthatches.

In August 2004 in anticipation of the 2005 breeding season, we reduced the size of the entrance hole on approximately one-fourth of the boxes on four of our golf courses. Prior to the 2008 breeding season, we reduced the hole size on approximately one-third of the boxes on two additional courses. We then compared the relative frequency of nuthatch nesting on these six courses before and after the partial exclusion of bluebirds. If the lack of nuthatch nesting is due to competition with bluebirds, we should observe a substantial increase in the number of nuthatch nests in the year following the partial transition to bluebird-proof nest boxes.

As shown in Figure 1, the availability of even a modest number of bluebird-proof boxes in year x+1 resulted in a significantly greater number of nuthatch nests compared to year x. This strongly suggests that the paucity of nuthatch nests in standard nest boxes on North Carolina golf courses is due primarily to interference from bluebirds.

The response of nuthatches to the availability of bluebird-proof nest boxes was reminiscent of several classic studies involving European tits. van Balen et al. (35) reduced the size of entrance holes on cavities normally used by European Starlings and observed a significant increase in the numbers of Great Tits using these cavities. In their study of the interactions between Great and Blue Tits, both Lohrl (22) and Dhondt and Eyckerman (10) observed increases in nesting by Blue Tits when they reduced hole sizes to exclude Great Tits. Our results suggest that equipping some golf course nest boxes with smaller holes could provide real benefits to these threatened nuthatches.

Question 2: What about pines?

As mentioned above, the Brown-headed Nuthatch is considered by many to be an obligate pine specialist. Because of their dependence on old growth pine stands, one should not expect to find many nesting on suburbanized golf courses. Our documentation of dramatic increases in nuthatch nesting following the reduction of competition with bluebirds suggests that habitat quality may not be as important to nuthatches as has previously been proposed. Which then is a better predictor of nuthatch nesting in golf course nest boxes: bluebirds or pines?

To quantify the pine density at each nest box, we measured the distance from each box to the three nearest pine trees (typically *P. echinata*). Pine trees more than100 meters away were recorded as more than 100 meters. Boxes for which the third closest pine was less than 50

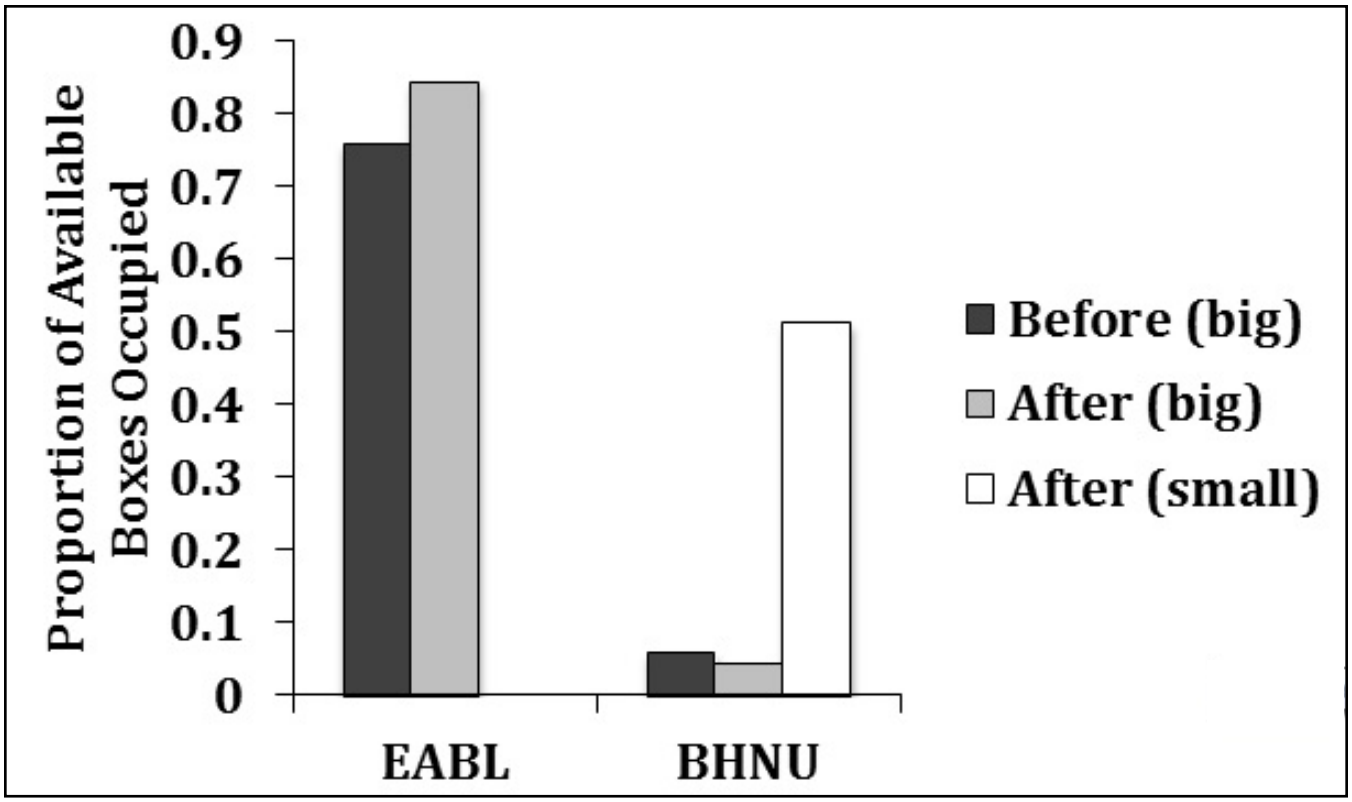

Figure 1. Proportion of nest boxes containing successful bluebird (EABL) and nuthatch (BHNU) nests before (year x) and after (year x+1) entrance holes on 30% of the boxes were changed from 38-mm to 28-mm (bluebird-accessible to bluebird-proof).

meters were designated as being in pine-rich habitat. Boxes for which the third closest pine was more than 50 meters away were considered to be in pine-poor habitat. Although the 50-meter cut-off was somewhat arbitrary, the majority of "pine-rich" boxes were in the category "less than 10 meters", and the vast majority of "pine-poor" boxes are in the category "more than 100 meters".

We then monitored the use of nest boxes on our local golf courses. At four of these courses, approximately 30% of the nest boxes had been retrofitted with bluebird-proof entrance holes (see above). Consequently, we were able to compare nest box occupancy in the presence and absence of competition with bluebirds and also in the presence and absence of pines. Bluebirds successfully nested in the vast majority of large-holed nest boxes at every site in every year of the study.

Combining the years 2005-2008, bluebirds nested in 83% of 435 large-holed boxes in pine-rich habitat and 79% of those in pine-poor habitat, demonstrating that bluebirds exhibit no preference regarding pine density. We then analyzed nest distribution in nuthatches considering both pine density (pine-rich vs. pine-poor) and bluebird competition (large- vs. small-holed boxes). For these analyses we used data from 2005-2007 from our four courses that contained both large and small-holed boxes.

We first compared the use of large-holed boxes in pine-rich vs. pine-poor habitats. Of 141 large-holed boxes in pine-poor habitat, 6% were occupied by nuthatches. Of of 185 large-holed boxes in pine-rich habitat, only 2% were occupied by nuthatches. We then compared the use of small-holed boxes in pine-rich vs. pine-poor habitats. Of 34 small-holed boxes in pine-poor habitat, 44% were occupied by nuthatches, compared to 62% of 118 small-holed boxes in pine-rich habitat. Although these trends each approached significance, they were in opposite directions. Thus pine density had no significant effect on the distribution of nuthatch nests on our four golf courses. This is especially noteworthy consider-

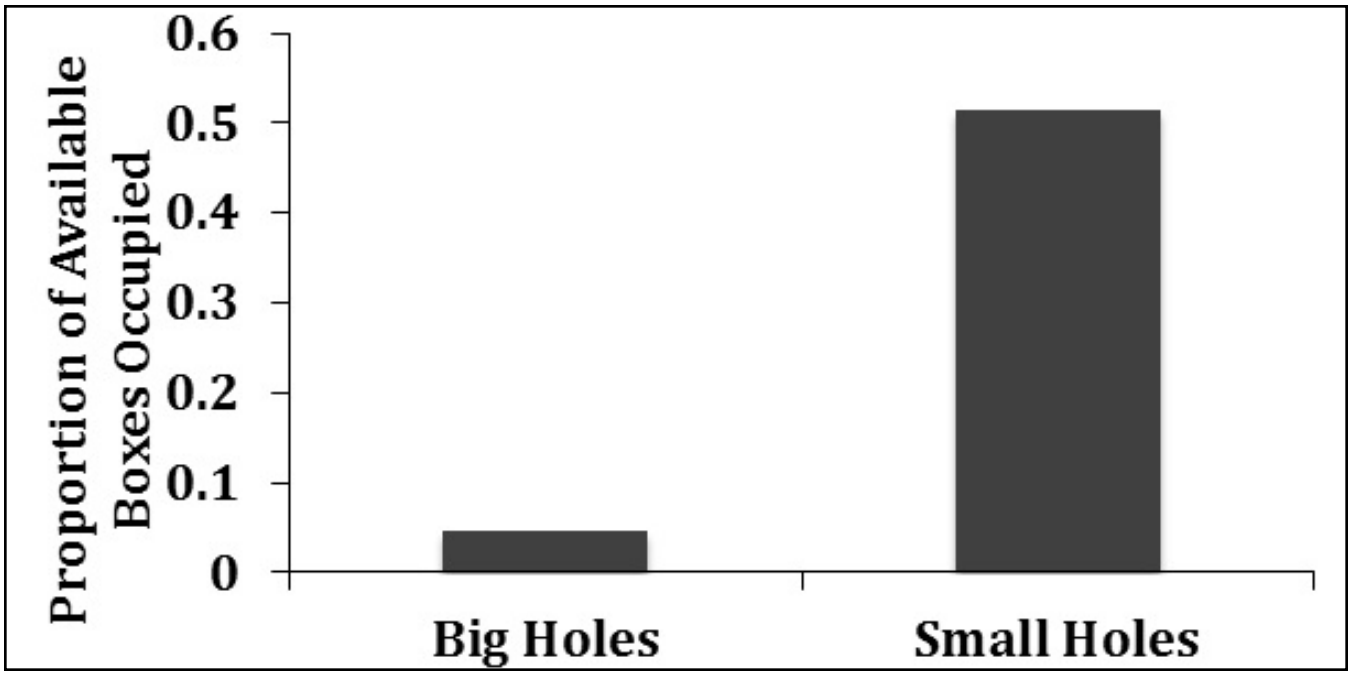

Figure 2. Proportion of bluebird-accessible (big) and bluebird-proof (small) nest boxes containing successful nuthatch nests after 30% of the boxes were made bluebird-proof.

ing that the majority of "pine-poor" boxes were more 100 meters from their third closest pine.

In contrast, nuthatches used bluebird-proof nest boxes far in excess of expectations. Only 6% of 141 large-holed boxes in pine-poor habitat were occupied by nuthatches, compared to 44% of 34 small-holed boxes. Only 2% of 185 large-holed boxes in pine-rich habitat were occupied by nuthatches; 62% of 118 small-holed boxes in similar habitat were occupied by nuthatches – another highly significant difference. These results demonstrate that although nuthatches undoubtedly require access to some pines, they can breed successfully in areas with surprisingly few pines – as long as they are shielded from competition from bluebirds.

Question 3: Can bluebirds actively displace nuthatches from nest boxes?

That bluebirds prevent occupancy of nest boxes by nuthatches need not imply that bluebirds are capable of usurping active nuthatch nests. To test this possibility, we returned bluebird-accessible holes to boxes that had been bluebird-proof from 2005-2007 and for which many had contained nuthatch nests in 2007. The return of bluebird-accessible entrance holes resulted in large-scale usurpation. Twenty nuthatch nest starts were taken over by bluebirds; only one nuthatch nested successfully in a bluebird-accessible box in 2008. Moreover, bluebirds prevented any nesting attempts at 11 additional nest boxes that had housed nuthatches in 2007. In other words, 97% of the 32 boxes used by nuthatches in 2007 were used by bluebirds in 2008.

Why were some bluebirds able to prevent even temporary settlement by nuthatches while others waited until after nuthatches had begun nest-building to evict them? The timing with which we performed our manipulations provides some clues. At one course, we returned bluebird-accessible holes to boxes in June 2007 so that in spring of 2008, these boxes could potentially be claimed by both 2007 spring nuthatches and 2007 summer bluebirds. At the second course, we returned bluebird-accessible holes in early August 2007, after the end of the 2007 bluebird breeding season. Although no bluebirds were able to use these boxes in 2007, the boxes were accessible to bluebirds throughout the fall and winter prior to the 2008 breeding season. At the third course, we

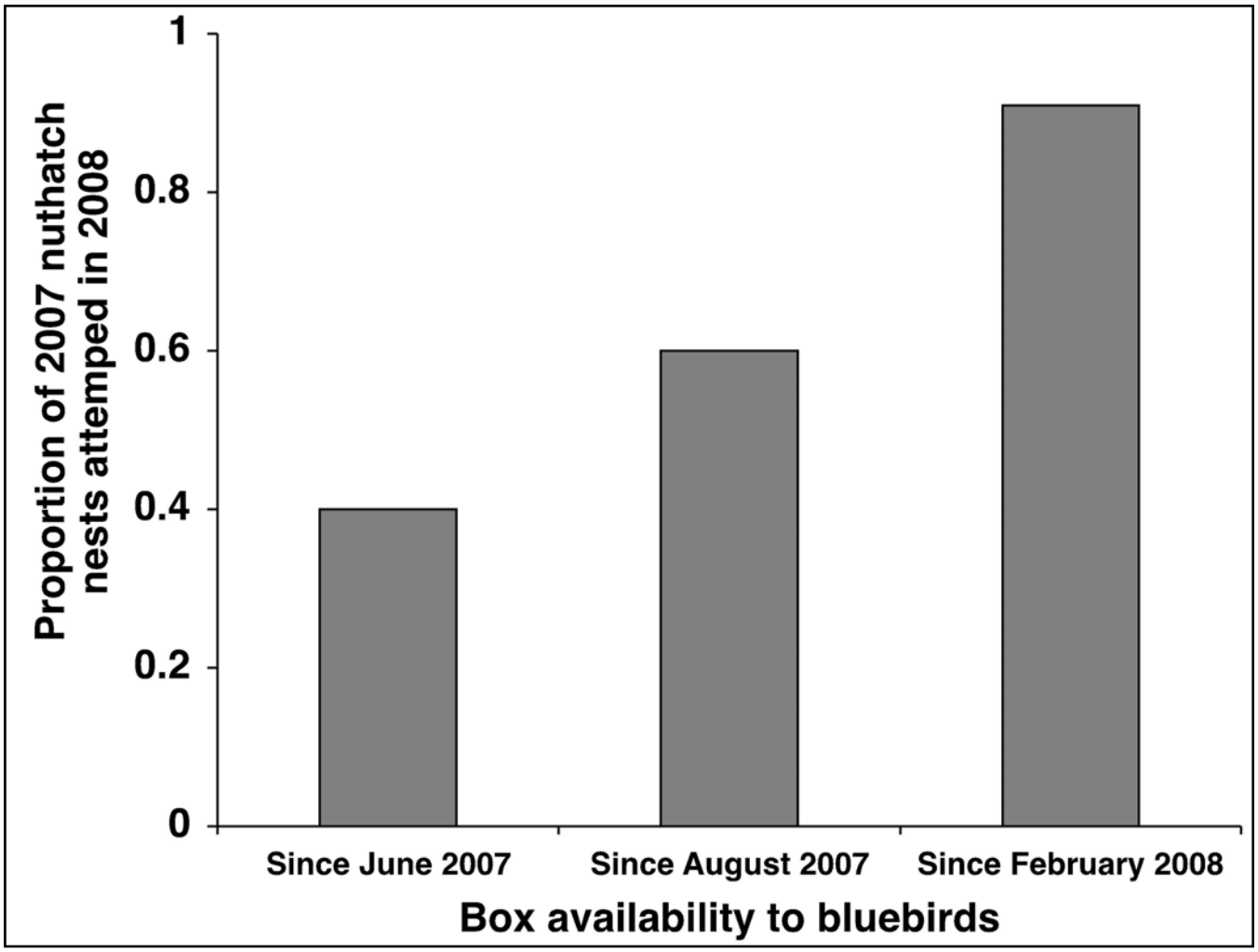

Figure 3. Effect on Brown-headed Nuthatches of making nest boxes accessible to bluebirds prior to the 2008 breeding season. We observed the fewest nuthatch nest attempts on the course where bluebirds had access to boxes since June 2007. We observed the most nuthatch attempts on the course where boxes were not made available to bluebirds until February 2008. Of the 20 nuthatch nest attempts made in these boxes, all but one were usurped by bluebirds

returned 38-mm holes to boxes in early February 2008, at the onset of the nuthatch breeding season. This final treatment minimized the time available for discovery and defense by bluebirds and maximized the probability that nuthatches would be successful in maintaining these boxes in 2008.

Boxes that were made available to bluebirds only weeks before the onset of the 2008 breeding season were monopolized by bluebirds just as effectively as boxes that received bluebird-accessible entrance holes in early June 2007 and were used by bluebirds during the summer of 2007. This is not to say that access made no difference. Where bluebirds had only one month of access prior to the 2008 breeding season, over 90% of nuthatches attempted to nest in the boxes they had used in 2007 (Figure 3). With seven months of bluebird access, only 60% of nuthatches attempted to nest, and with 9 months of access, only 40% of nuthatches attempted to breed in the nest boxes (Figure 3). This suggests that bluebirds not only are capable of usurping active nuthatch nests, but also defend nest sites during the non-breeding season (12). Clearly, our data contradict statements by Withgott and Smith (36) that "There is no evidence, however, that cavity competitors are regularly able to exclude nuthatches from nest sites once established."

Question 4: Does pairing standard boxes allow bluebirds and nuthatches to coexist?

In some parts of their range, bluebirds commonly compete for nest sites with Tree

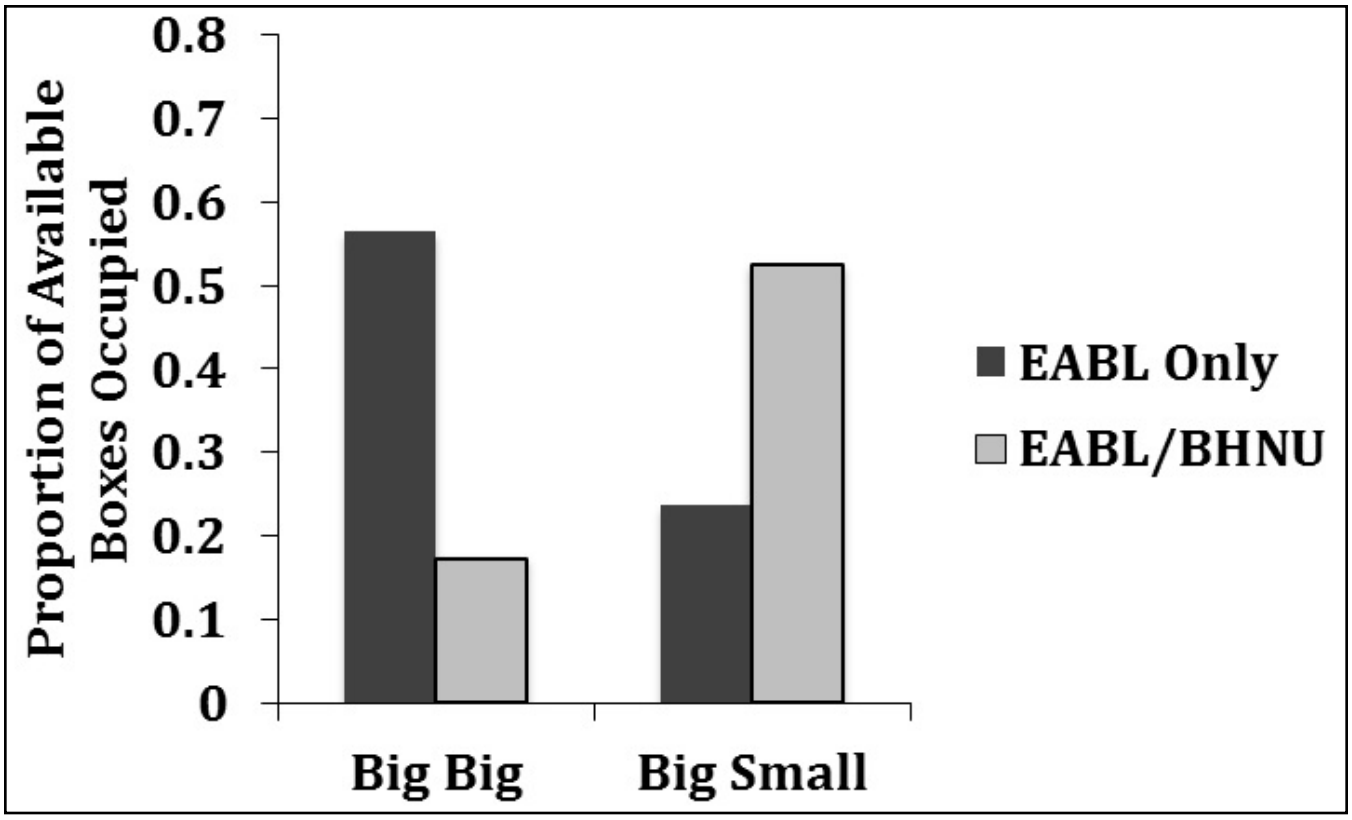

Figure 4. Bluebirds monopolized paired standard (bluebird-accessible) boxes, largely preventing nesting by nuthatches. However, when bluebird-accessible boxes were paired with bluebird-proof boxes, nuthatches frequently nested adjacent to bluebirds.

Swallows. A common strategy to promote the coexistence of both species in these areas is the pairing of nest boxes. Although this practice is not without controversy, there is reason to expect that established Tree Swallows pairs will prevent the settlement of an additional pair of Tree Swallows in the immediate vicinity, but not prevent the settlement of a pair of bluebirds.

Following this logic, it seemed prudent to test whether bluebirds might tolerate nesting by nuthatches when provided with two standard nest boxes. Starting in 2009, we paired up most of the nest boxes on our six local golf courses. Inter-pair distances were generally similar to the inter-box distances of prior years. Within pairs, boxes were approximately 10 meters apart. In some pairs, both boxes were given 38-mm (standard) holes; at other pairs, one box had a 38-mm hole and the other a 28-mm hole; and at yet other pairs, both boxes had 28-mm holes. We then monitored the boxes in order to determine whether pairing facilitated coexistence of bluebirds and nuthatches.

Contrary to expectations, bluebirds did not exhibit a willingness to allow nuthatches to nest in adjacent standard boxes. Instead, bluebirds appeared to monopolize both boxes, even though they only used one for nesting (Figure 4). At 23 "big/big" box pairs containing a bluebird nest, only 4 also contained a nuthatch nest. However, at 139 "big/small" box pairs with a bluebird nest, 74 also contained a nuthatch nest.

These results suggest that pairing standard (bluebird-accessible) nest boxes is not a viable management strategy for increasing nesting by nuthatches on southeastern golf courses. Although bluebirds and nuthatches are willing to nest side-by-side when one box is bluebird-proof, we have no evidence that such pairing is better than simply providing a subset of nest boxes with bluebird-proof entrance holes.

General Management Implications

Although we agree that Brown-headed Nuthatches are dependent on pines, our data suggest that some "suboptimal" habitats may be sub-

optimal as a result of an abundance of bluebirds rather than paucity of old-growth pines. By manipulating nest boxes on suburban golf courses, we clearly demonstrated both the competitive exclusion of Brown-headed Nuthatches by Eastern Bluebirds and the ecological release of nuthatches in the absence of bluebirds.

That bluebirds have been the primary beneficiaries of golf course nest box programs is becoming increasingly clear. Simply adding moderate numbers of nest boxes to a habitat will not automatically benefit all members of the secondary cavity nesting guild: only after dominant species achieve their maximum density will subordinate species benefit from remaining nest boxes. This is not to say that nest box programs cannot reduce such monopolization. Indeed, increasing nest box density can be an effective means of altering competitive asymmetries (25).

Despite the large numbers of nest boxes that have appeared on southeastern golf courses, the density of these boxes has been insufficient to benefit Brown-headed Nuthatches. In fact, by making golf courses demographic sources for bluebirds, standard nest box programs may even be detrimental to Brown-headed Nuthatches. Our data suggest that the recommended nest box density on golf courses (100 meters apart; 11) simply guarantees bluebird hegemony. Even a doubling of this recommended density (a potentially expensive step that few golf course managers would be willing to take) would not guarantee an increase in nuthatch nesting.

Surprisingly, our data clearly demonstrate that the pairing of standard nest boxes (also a potentially expensive endeavor) provides no benefit whatsoever to nuthatches. When provided with two standard boxes, bluebirds tend to defend both. Although we have data suggesting that pairing two bluebird-proof boxes might alleviate nest site competition between nuthatches and Carolina Chickadees, we also understand that most golf courses are interested in making their nest box programs both visually unobtrusive and fiscally prudent.

Some may argue that golf courses comprise too small a part of the range of the Brown-headed Nuthatch to make a difference in their recovery. We disagree. The seven states that make up the core of the range of the Brown-headed Nuthatch (NC, SC, GA, FL, AL, MS, LA) contain over 4,000 golf courses. Additionally, southeastern golf courses mimic many aspects of pine savannahs, with well-spaced trees and an open understory (13). Moreover, a large number of these courses already have nest boxes, usually the result of efforts to be more wildlife-friendly. If southeastern golf courses take steps to break the nest box monopoly enjoyed by Eastern Bluebirds, the benefit to Brown-headed Nuthatches could be substantial.

Given the dramatic response of our Brown-headed Nuthatches to bluebird-proof nest boxes, the thousands of golf courses in the range of the Brown-headed Nuthatch, the ubiquity of bluebirds across this range, and the societal pressure for golf courses to provide nest boxes, golf course managers would be remiss if they ignored such an opportunity to increase the value of marginal habitat for the Brown-headed Nuthatch.

Specific Recommendations to Enhance Nesting by Brown-headed Nuthatches

- Golf courses in the Southeast, even those without extensive pine stands, should consider providing nest boxes for Brown-headed Nuthatches.

- Nest boxes should be pole-mounted with predator guards.

- There is no need to pair standard nest boxes to increase occupancy by nuthatches.

- Every other box should have a one-inch entrance hole to accommodate Brown-headed Nuthatches and Carolina Chickadees but exclude bluebirds and house sparrows.

- Existing bluebird-accessible boxes can be retrofitted with a metal disc with a one-inch hole.

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