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Assessing Nest Success of Black-Capped Chickadees (*Poecile atricapillus*) in an Urban Landscape Using Artificial Cavities

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ABSTRACT.—Native bird diversity is compromised in urban areas partially because of the lack of available habitat for some species. As urbanization continues to increase, it is important to understand the behavioral dynamics of bird species located in cities. The Black-capped Chickadee (*Poecile atricapillus*), as a generalist species, offers an opportunity to investigate how common native birds use urban areas that lack natural habitat features while additionally competing with non-native, invasive species (e.g., House Sparrows, *Passer domesticus*). Our objectives were to determine nest box use and nesting success rate of Black-capped Chickadees and House Sparrows using artificial nest boxes in natural habitats located in an urban area, specifically a recently restored 5.66- ha area of pond sedge surrounded by oak (*Quercus* spp.) savannah located south of Lincoln Park Zoo in Chicago, Illinois, USA. Artificial nest cavities with 3 cm diameter entrance holes, intended to exclude House Sparrows, were installed on trees around the study site and monitored for activity. We found that Black-capped Chickadees will readily use artificial cavities; seven of the 20 boxes were excavated and four produced nests. The artificial nesting cavities successfully excluded House Sparrows from nest building and raising young. *Received 8 September 2015. Accepted 22 November 2015.*

Key words: artificial cavity, Black-capped Chickadee, House Sparrow, invasive species, nest success, urban ecology, wildlife management.

Cavity nesting birds depend on standing dead trees (snags) or dead limbs of sufficient size to successfully fledge their young. The abundance of these species is in part related to the density of snags within a habitat patch. In urban centers, snags and dead tree limbs are often removed for aesthetic or safety reasons which can lead to an overall decrease in cavity nesting species (Blewett and Marzluff 2005). Additionally, the high density of invasive House Sparrows (*Passer domesticus*) in urban areas may increase competition for available nesting habitat because the sparrows are strong competitors that often choose nest sites indiscriminately (Anderson 2006, Lowther and Cink 2006).

Artificial cavities, or nest boxes, can provide alternative nest sites for cavity nesting species (May 2001). The use of these nest boxes has been shown to increase the abundance of cavity nesting bird species in the vicinity (Newton 1994), while providing the opportunity for smaller species to breed at a higher frequency prior to the implementation of nest boxes (May 2001, Charter et al. 2010). Although artificial nest cavities have been shown to benefit native species in natural environments (Newton 1994), this has yet to be quantified in urban areas where snags are less abundant and non-native nest site competitors are more common. Thus, we investigated how artificial nest boxes influence the abundance of a native cavity nesting species known to readily use urban areas without providing nesting habitat for the invasive House Sparrow.

The Black-capped Chickadee (*Poecile atricapillus*) is an ideal study candidate because of its high relative abundance in urban areas compared to other native cavity nesting species, and its smaller size in relation to the House Sparrow (Melles et al. 2003). We hypothesized that Black-capped Chickadees would nest in artificial cavities with an entrance size larger than the body size of adult Black-capped Chickadees but smaller than the body size of adult House Sparrows, while House Sparrows would not be able to fit because of the entrance size. Therefore, the goal of this

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study was to determine the nesting success rate and cavity use of the Black-capped Chickadees in artificial cavities within an urban area, and to determine whether cavity entrance size could be used to exclude House Sparrows from a nest box, thereby reducing the effect of competitive exclusion for nest sites for Black-capped Chickadees and increasing their breeding densities. We also compared the relative frequency of Black-capped Chickadees after artificial nest boxes were installed to 2 years of previously collected data from the same location to determine if nest boxes positively influenced the likelihood of observing the species.

METHODS

The study site, known as Nature Boardwalk (41° 55′ N, 87° 37′ W), is a 5.66-ha plot dominated by hardwood tree species and managed primarily as an oak savannah. The site contains a 1.69-ha pond with a path that circles its entire perimeter and is located just south of the Lincoln Park Zoo near downtown Chicago, Illinois, USA.

To assess site use of a native cavity nesting bird, the Black-capped Chickadee, we set 20 artificial cavities, attached to trees, within the site. Nest box construction followed the North American Bluebird Society (NABS) original box model (NABS 2012). The entrance holes were $\leq$3 cm diameter. A 3-cm entry hole targets White-breasted Nuthatches (*Sitta carolinensis*), Red-breasted Nuthatches (*Sitta canadensis*), and Black-capped Chickadees (Mennill 1999, May 2001). Nest boxes were installed 7 weeks prior to the breeding season (late Mar through early Aug 2013) to allow individual pairs time to habituate to and investigate the nest boxes prior to the breeding season. The boxes were placed at least 30 m apart to prevent territorial disputes between nesting pairs (Stefanski 1967, Otter et al. 1998). All boxes were filled with pine wood shavings to simulate a fresh cavity.

Nest box data collection followed recommendations from the University of Montana Breeding Biology Research and Monitoring Database (Martin et al. 1997). Observations were initially made once per week for 5 mins from 1 March – 1 August 2013. During observations, data collected included: excavation of cavity, addition of new nest material, presence of eggs, laying and incubation of eggs, presence of nestlings, and fledgling activity. Observers used the presence of nesting material in a box after selection to identify a box as active. Active boxes were opened biweekly to determine nest status. Nest success was defined by the production of at least one fledgling. A nest was considered terminated at the last observation of a parent caring for eggs or young. Nesting success rates were calculated using the Mayfield calculation (Mayfield 1961, 1975), which is based on exposure during nesting periods, and focuses on incubation, hatching, and survival to fledging. Excavations were not considered nest attempts as paired male chickadees have been observed excavating and inspecting nest holes while they have eggs incubating in another nest (Odum 1941).

To determine the relative sighting frequency of Black-capped Chickadees each breeding season, the number of days chickadees were observed was divided by the total number of daily counts that occurred within the breeding season at the study site from 2011–2013. Counts were conducted as often as possible during the breeding season. For each count, one trained observer would start at the northernmost section of the pond and walk at a steady rate, 2 mph, around the perimeter of the pond between 0700–0900 CST, making note of species present within the area of the park. Counts were completed within 15 mins. Bird species were identified by song or visual identification by trained observers.

To determine the effect that nest boxes had on presence of Black-capped Chickadees at our site, we fit a logistic regression model using Program R Version 3.0.2 (R Core Team 2013) and compared the frequency of detections of Black-capped Chickadees for the 2 years before nest box placement to the frequency of detections of Black-capped Chickadees the year the nest boxes were added. Presence/absence of Black-capped Chickadees was considered the response variable (respectively coded as “1” and “0” in the analysis), while presence of nest boxes was treated as a discrete explanatory variable. After the regression was applied, a Wald test was used to measure the effect of nest boxes (Agresti 1996).

To observe how frequently House Sparrows attempted to enter nest boxes, motion-triggered wildlife cameras (Trophy Cam model 10436, Bushnell, Overland Park, KS, USA) were placed 1 m from three nest boxes previously observed as highly active for Black-capped Chickadees during time leading up to the breeding season.

TABLE 1. Nest success rate of Black-capped Chickadees in artificial nest boxes at Nature Boardwalk, Chicago, Illinois in 2013.

Nest number	Eggs laid	Incubation phase nest days	Incubation phase success	Hatchlings	Hatchling phase nest days	Fledglings	Nestling phase success	Nest survival rate
2	6	5	0.72	0	0	0	0	0
6	7	1	0.93	0	0	0	0	0
19	6	12	0.46	6	20	6	1	0.46
20	6	14	0.40	6	14	4	1	0.40
Totals	25	32		12	34	10		
Mean ± SE	6.25 ± 0.25	8 ± 3.03	0.62 ± 0.12					
Hatch success	0.48							

Motion-triggered cameras placed outside of nest boxes provided information on the species that interacted with the box and times when the boxes were active. Cameras were active from 1 March – 1 August 2013, with 306 camera days, each camera pointed directly at the entrance of the box and was programed to take two pictures at 10-sec intervals when triggered by motion (sensitivity set to normal).

RESULTS

During the 2013 breeding season, seven of the 20 nest boxes were excavated. Of those excavated, four produced nests. The four nests had a combined total of 25 Black-capped Chickadees' eggs with an average clutch size of 6.25 (0.25 SE; Table 1), which is comparable to results from other studies (Otter et al. 1999, Ramsay et al. 2000). Two nests successfully produced nestlings, six each, with 10 of the nestlings (83%) successfully fledged. The remainder died of unknown causes. The two nestling mortalities occurred in a single nest box, ~2 days before the other nestlings in the box fledged.

The incubation phase consisted of 32 nest days over four nests, with two nest failures. The survival rate for the incubation period was 0.94/incubation day. The nests that succeeded in producing fledglings had an average nest survival probability of 0.42. The average total nest success rate was 0.22 (0.12 SE). Relative frequency of sightings of Black-capped Chickadees was highest during the 2013 breeding season (nest boxes present) compared to 2011 and 2012 (nest boxes not yet placed; Table 2). Furthermore, the odds of observing Black-capped Chickadees increased 2.42 times after nest boxes were installed (Wald test, $P < 0.001$).

Camera traps revealed that House Sparrows made >15 attempts to enter the nest boxes but could not fit. The House Sparrows failed to produce nests in any of the boxes. Other species that interacted with the nest boxes include: Red-breasted Nuthatch, Black-and-white Warbler (*Mniotilta varia*), House Wren (*Troglodytes aedon*), eastern grey squirrel (*Sciurus carolinensus*), bumble bees (*Bombus* spp.), and humans. Red-breasted Nuthatches and House Wrens were observed investigating the boxes but did not attempt to nest; Black-and-white Warblers were only observed foraging around the boxes for insects. Camera traps did not observe any nest predation during this study.

DISCUSSION

Our study offered a preliminary exploration into the suitability of artificial cavity nests for cavity nesting birds in Chicago, Illinois, USA. The 20 nest boxes placed at the study site provided Black-capped Chickadees with nesting opportunities that were not present prior to the start of the project, which correlated with an increase in their overall observed frequency at this urban park. A nest entrance diameter of 3 cm successfully excluded House Sparrows but allowed Black-capped Chickadees to enter nest boxes. We therefore consider the use of a 3-cm diameter entrance hole an effective method to prevent House Sparrows from using nest boxes but create nesting opportunities for smaller native species. However, to exclude House Sparrows from artificial cavities throughout North America, the entrance diameter may have to be sized differently according to regional variation in body sizes of House Sparrows. Species size may change over a latitudinal gradient as supported by Bergmann's Rule, a general intraspecific tendency towards larger body size in cooler areas and at higher latitudes (Bergmann 1848, Ashton 2002). As

TABLE 2. Relative frequency of Black-capped Chickadees by year at Nature Boardwalk, Chicago, Illinois prior to placement of artificial nest boxes (2011 and 2012) and during the presence of artificial nest boxes (2013).

Year	Days Black-capped Chickadees counted	Counts performed	Relative frequency
2011	18	130	0.14
2012	45	160	0.27
2013	50	110	0.46

a result, exclusion via a 3-cm cavity entrance may not succeed for House Sparrows at more southern latitudes. Likewise, Black-capped Chickadees living at a more northern location than Chicago may struggle to enter an artificial cavity with a 3-cm nest entrance diameter. To manage exclusion of House Sparrows, the diameter of the nest box hole may need to be adjusted based on the body size of both species at the specific latitude. The motion-triggered cameras showed that a 3-cm nest entrance did not exclude House Wrens (*Troglodytes aedon*). If preventing this species is necessary, we suggest the use of a wren guard (Orthwein 1995).

Although our study provides information on nesting behavior and success in urban areas, further research on the nesting behavior of cavity dwelling species near urban environments is needed (LaMontagne et al. 2015). Our study indicates that providing artificial nest boxes can help manage Black-capped Chickadees in urban areas, an essential step towards effective wildlife management and conservation on an urbanizing planet. As nest boxes cost little to construct and are relatively simple to build, there is a significant opportunity to not only positively influence native cavity nesting species in urban environments but also to include the public in urban conservation.

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Prevalence of Disjunct Roosting in Nesting Bank Swallows (*Riparia riparia*)

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ABSTRACT.—Bank Swallows (*Riparia riparia*) congregate in large nocturnal roosts during the non-breeding season. Scant evidence suggests that Bank Swallows may also congregate regularly in nocturnal roosts during the breeding period. To help clarify the issue, we used automated radio-telemetry to document the roosting behavior of 11 males and 11 females that were tending nests with young at two nesting colonies. Nineteen of the 22 birds (86%) spent at least one night roosting away from the colony, and 13 of the 22 birds (59%) spent at least one night roosting likely within a large marsh located ~30 km away from the colonies. Females tended to roost overnight at the colony more than males. The proportion of nights birds spent roosting away from the colony was highly variable between individuals. Minimum flight speeds to an evening roost site (~30 km distant) were significantly greater than return flights back to the colony in the morning. Our study confirms that breeding Bank Swallows do in fact regularly roost away from the colony during the nestling period. Our study also highlights some new and intriguing questions regarding how Bank Swallows use the landscape during the breeding season, and the potential importance of wetland roost sites in the proximity of breeding colonies. *Received 24 March 2015. Accepted 10 October 2015.*

Key words: Bank Swallow, movements, radio telemetry, *Riparia riparia*, Sand Martin.

Swallows (Hirundinidae) are known for their gregarious roosting habits during post-breeding, migratory stopover, and wintering periods, in which large numbers of individuals congregate at night to roost (Ormerod 1991, Russell et al. 1998, Garrison 1999, van de Brink et al. 2000, Winkler 2006). Roosts can consist of thousands or sometimes even millions of individuals in mixed-species flocks (Turner 2006). Typical roost sites include large marshes or reed beds, shrub thickets over water, agricultural crops and sometimes trees (Alves and Johnstone 1994, Garrison 1999, Turner 2006, Winkler 2006).

While the use of nocturnal roosts outside the breeding period is well documented, there is far less evidence of swallows using nocturnal roosts during the breeding season. Exceptions include Purple Martins (*Progne subis*; Cater 1944, Tarof and Brown 2013), and the following observations for Bank Swallows (*Riparia riparia*). Beyer (1938) observed adult Bank Swallows leaving nests in the evening to roost in nearby marshes, even though their nests contained "partially grown" nestlings. Alves and Johnstone (1994) observed a pair of radio-tagged Bank Swallows roosting overnight in agricultural crops up to 6 km away from the nest, while the nest contained young 9–17 days old.

The observations described above suggest that Bank Swallows commute to roosting habitat during the breeding season. However, it remains uncertain how widespread the behavior is within or among individuals and nesting colonies and how far individuals are willing to commute to breeding season roosts. Here, we aim to address these questions using lightweight radio tags and automated radio telemetry towers to describe movement and roosting patterns of a number of individual nesting Bank Swallows at two breeding colonies.

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