The Effects of Supplemental Feeding on Eastern Bluebird (*Sialia sialis*) Parental Care

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Abstract: Balancing energy consumption and nestling demand can result in trade-offs between future reproductive success and body condition with offspring survival. As bird feeding is becoming a popular and multi-billion dollar hobby, this supplemental food has resulted in positive and negative consequences, such as increased reproductive success and increased disease transmission, respectively. Since eastern bluebirds display biparental care, we utilized this model to determine the effect of supplemental food on parental care. Feed watch videos were set up inside and outside sixty one nest box sites between 5 and 7 days after hatching to record nest visitation rate of males and females in 2015 and 2016. We found no effect of the supplemental food on visitation rate but did see an increase in visitation rate between years. Many environmental factors, such as temperature, inclement weather, predator density, can influence parental care behavior which may explain the lack of effect the supplemental food had on visitation rate. Future studies should be conducted with longer durations to determine supplemental food effects in different environmental conditions.

Keywords: Supplemental Food, Parental Care, Eastern Bluebirds, Anthropogenic Disturbance

Introduction

Parental care investment is energetically taxing and can affect body condition, reproductive success, survival of the offspring and occurrence of other energy-demanding behaviors (Zolderdo et al., 2016). For example, Fontaine and Martin (2006) studied nest defense and parental care behaviors within a community of birds and found that perceived lower predation risk allowed parental care investment to increase (more energy allocated towards parental care), which resulted in increased egg size, clutch mass, and feeding rate. Reproductive success is limited by parental feeding rates as the offspring are fully dependent until fledging. Gladalski et al. (2016) found that lower feeding rates caused detrimental effects on nestling body condition in blue tits (*Cyanistes caeruleus*), decreasing the likelihood of survival.

Bird feeders introduce supplemental feeding with positive consequences (increasing reproductive success, moving lay dates earlier, increasing parental attention, and hatching asynchrony) and negative consequences (inaccurately promoting habitat quality, causing dependence on provisions, migrating not as necessary, increasing disease transmission, and increasing predation (Robb, 2008). Kaiser et al. (2014) found food supplementations in black-throated blue warblers (*Setophaga caerulescens*) did not directly affect male parental care behavior, did increase androgen levels, and found that females showed higher provision rates, higher biomass, and more time spent in the nest box. In a study conducted by Dewey and Kennedy (2001), they tested supplemental feeding on Northern Goshawks (*Accipiter gentilis*) and found that female goshawks and nestlings had higher

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body masses when fed supplemental food. However, the female nest attendance was the same for the control and treatment group during brooding, indicating that food availability does not affect behavior when nestlings were dependent on their parents for thermoregulation. Once the young could thermoregulate, females in the treatment group stayed closer to the nests than the control females who were most likely out foraging for food. Supplemental feeding can affect parental care behavior as well as the resulting body condition and offspring survival.

The eastern bluebird (*Sialia sialis*) is a small-sized (average mass of 29-32 g for females and 28-31g for males) passerine in the family Turdidae ranging in location from southern Canada through eastern United States to northern Mexico while practicing partial migration based on weather and food availability (Gowaty and Plissner, 2015). Eastern bluebirds are usually socially monogamous with rare observations of socially polygynous behavior (Gowaty and Plissner, 2015). Burtka and Grindstaff (2013) found that female eastern bluebirds are consistent in their nest defense behaviors against the house sparrow (*Passer domesticus*) while male eastern bluebirds showed more plasticity in their behavior between years. Within mating pairs, Burtka and Grindstaff (2015) found that coordination of behavior was more important than the intensity of nest defense behavior in their fledging success. Pair coordination of behaviors in eastern bluebirds (*Sialia sialis*) do not correlate with similar hormone levels (Burtka et al. 2016). The eastern bluebird population had previously declined due to competition over nest cavities, with invasive bird species such as the house sparrow (*Passer domesticus*) and European Starlings (*Sturnus vulgaris*) (Gowaty and Plissner, 2015), and due to habitat destruction from urbanization (Brown and Graham, 2015). Artificial nest boxes have been beneficial to the population numbers of eastern bluebirds and the rising popularity of bird watching within people's backyards has provided bird species with additional nest boxes and supplemental food, the latter which may affect parental care behavior. We hypothesized that the eastern bluebirds receiving supplemental food during the egg and nestling phase would visit the nest box less often to feed their nestlingsbecause foraging behavior to meet the nestlings demand would be reduced and the parents could allocate more energy towards other behaviors, such as nest defense or foraging for themselves.

Methods

Study System

We used eastern bluebirds to study the effects of supplemental feeding on parental care behaviors because there is a local population around Stillwater, Payne County, OK and past studies have demonstrated that eastern bluebirds display biparental care. Nest boxes were placed at least 50 m apart and 1.5 m from the ground on fence posts or t-posts in open areas and were checked twice a week from mid-February to July/August until the nest building was finished. The nest boxes were then checked daily for the lay date and 13 days later checked for when females started incubating. Between 5 to 7 days after hatching, two feed watches are recorded for parental visit rates.

Supplemental Feeding

Eastern bluebirds are insectivorous; therefore, the supplemental food given to the

birds was a set mass of mealworms. The nest boxes housed a plastic cup that allowed the researchers to place mealworms inside the box. Nest boxes were randomly assigned a supplemental feeding group. The "Full" group received 15 mealworms per bird throughout the nesting cycle, in which mealworms were placed in the box during the egg and nestling phase. The "Part" group received 15 mealworms per bird during the egg phase only, and the "Control" group received no mealworms. An additional "Control" group was tested in which no plastic cup was installed inside the nest box.

Parental Care

Sixty one nest boxes were recorded between 7 and 11 am 5-7 days after hatching with digital camcorders 10 m from the nest box and Raspberry Pi cameras (RPi Foundation, 2015) inside the nest boxes to observe parental behaviors. Burtka and Grindstaff (2015) utilized similar video cameras and found the birds to not be affected by the cameras. Nest boxes were recorded twice a year, to determine consistency of behavior, for nest visit rate and nestling provisioning rates. Videos from the nest boxes were analyzed with VLC media player and we recorded the visitation rate (the number of visits to the nest box per nestling per hour) and the fecal sac removal rate (the number of fecal sacs removed per nestling per hour).

Statistical Analyses

We conducted an analysis of variance (ANOVA) in R (version 3.2.2) with each supplemental group (control no cup, control no supplementation, part supplementation, full supplementation) as the explanatory variable and visitation rate (number of visits to the nest box per nestlings per hour) as the response variable. Individual identity was included as a random effect to account for repeated sampling.

Results

Overall, we found no significant difference in male and female visitation rate across supplemental food groups (Males: $F = 0.546$, $p = 0.652$. Females: $F = 0.194$, $p = 0.334$; Figure 1). In 2016, visitation rates were significantly higher than 2015 for females (Males: $F = 1.499$, $p = 0.224$. Females: $F = 7.383$, $p = 0.008$; Figure 2). We also found that visitation rate across years and supplemental food groups did not significantly differ (Males: $F = 0.820$, $p = 0.574$. Females: $F = 1.162$, $p = 0.334$).

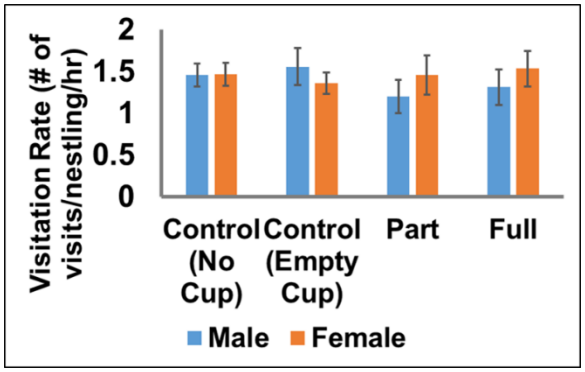

Figure 1 - Average visitation rate of males and females in different supplemental food groups.

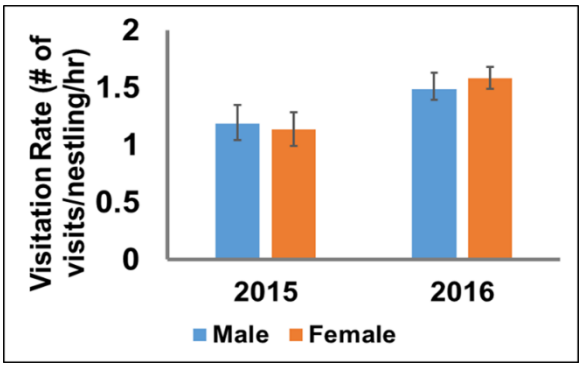

Figure 3 - Average visitation rate of males and females in 2015 and 2016.

Discussion

This study was conducted to determine if supplemental food influenced eastern bluebird parental care, focusing on visitation rate to the nest box. We found that supplemental feeding did not affect visitation rate, but between 2015 to 2016, visitation rate increased. Therefore, we conclude that supplemental feeding during the nesting cycle does not affect eastern bluebird parental care behaviors. A possible explanation for this conclusion could be that the supplemental food provided may not have affected visitation rate due to its nutritional value. Parental care behaviors have been shown to be sensitive to fluctuations in carbohydrates while aggressive behaviors are sensitive to levels of protein in the diet (Han and Dingemanse, 2015). The mealworms may have not affected the balance of carbohydrates in the diet of these eastern bluebirds. Future studies should be conducted utilizing different supplemental foods, such as waxworms or fruit, with varying nutritional value to determine if additional food affects parental care behaviors.

These results could also be explained by other environmental factors that have been found to influence avian parental care and nestling survival. Insect abundance in the area may have outweighed the additional nutritional value of the supplemented meal worms, and supplemental feeding effects were higher when natural food availability is low (Kaiser, 2014). Dawson and Bortolotti (2000) found that the years when prey was abundant, the parents could provide more food with lower energy expenditure. Therefore, supplementation given when food abundance is low, such as winter months (Crates et al., 2016), is more effective because it has greater impacts on diet and energy demands.

The increase in visitation rate between the years could be explained by differences in inclement weather or temperature in 2015 and 2016. Inclement weather, such as rain, has been shown to limit foraging behaviors and reduce parental body condition (Dawson, 2008). Dawson and Bortolotti (2000) found that weather patterns did not affect prey provision rate, however, delivery rate decreased as rain duration increased. Increase in rainfall could also lead to an increase in insect abundance due to greater plant biomass which could alter the effect of the supplemental feeding (Zhu et al., 2014). Warmer temperatures may affect the energy demand of thermoregulation allowing more energy to be allotted to other behaviors, such as foraging (Dawson, 2008). It would be valuable to conduct studies running for several years to determine the effect of supplemental food on parental care across different environmental conditions.

Anthropogenic disturbances and supplemental feeding may affect avian fitness through altered energy demands. Supplemental feeding can provide nutrients to balance energetically taxing behaviors, such as parental care, but these effects are influenced by the environmental conditions.

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