Turfgrass and Environmental Research Online

…Using Science to Benefit Golf

Researchers at the College of William and Mary, Williamsburg, VA, used radio-telemetry to track eastern bluebird fledglings on golf course and reference (non-golf) sites in southeastern Virginia. They wanted to determine what causes mortality in fledglings and compare survival on golf and reference sites. They found that bluebird fledglings have similar survival rates on golf courses and reference sites, with approximately 65% surviving to 40-days postfledging. In addition, bluebird survival was affected more by time of season than whether a bird was on a golf course or a reference site, with birds that fledged later in the season surviving better.

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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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Tracking Survival of Bluebirds on Golf Courses

Allyson K. Jackson and Daniel A. Cristol

SUMMARY

Although all fledglings (baby birds that have left the nest) generally suffer high mortality as they learn to fly and forage on their own, the habitat that the birds fledge into may impact mortality. Researchers at the College of William and Mary, Williamsburg, VA, used radio-telemetry to track eastern bluebird fledglings on golf course and reference (non-golf) sites in southeastern Virginia. They wanted to determine what causes mortality in fledglings and compare survival on golf and reference sites. The study's findings include:

- Bluebird fledglings suffer mortality due to hawk predation, starvation or disease, snake predation, and collisions with windows.
- Bluebird fledglings have similar survival rates on golf courses and reference sites, with approximately 65% surviving to 40-days postfledging.
- Bluebird survival was affected more by time of season than whether a bird was on a golf course or a reference site, with birds that fledged later in the season surviving better.
- Bluebirds use artificial nest cavities placed near open grass, but the fledglings suffer higher mortality when there is little forest cover around their nest box. Golf course managers can help bluebird fledglings survive by moving nest boxes into out-of-play areas near dense forest edges.

In areas where natural land is rapidly being converted to developments, golf courses often offer a refuge of open space for wildlife. Birds are particularly visible residents of golf courses, and few are more attention grabbing than the eastern bluebird (*Sialia sialis*). Eastern bluebirds inhabit golf courses up and down the east coast because they are "edge specialists," meaning that they prefer to nest and forage in areas at the intersection of forest and field (6). Golf courses, with their juxtaposed fairways and trees, are therefore prime real estate for bluebird nests.

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Bluebirds are secondary cavity nesters, so-called because they will only nest in cavities that have been excavated first by another species. Historically, they nested in old woodpecker holes, but in the present day they nest successfully in artificial nest boxes. Many local bird clubs and golf course managers now provide nest boxes for bluebirds, which attracts them to golf courses in high numbers.

Although bluebirds are common on golf courses, the use of pesticides and frequent human disturbance could make life difficult for bluebirds. Previous research has focused on nesting success (how many offspring the parents successfully raise), and has found conflicting results (7, 9). In Virginia, bluebirds produced more offspring on golf courses compared to reference sites (7), while in North Carolina, bluebirds raised fewer offspring on golf courses (9). Our current project is

Juvenile eastern bluebird fledglings are gray/brown colored to help with camouflage, unlike their brightly colored parents. Young fledglings are weak flyers and thus vulnerable to predation.

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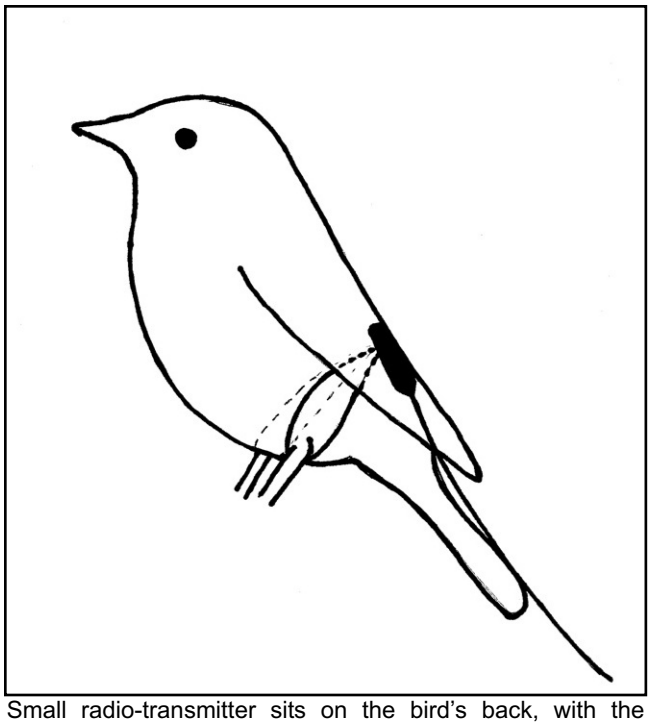

Small radio-transmitter sits on the bird's back, with the antenna extending out over the tail. It is secured by an elastic harness around the legs.

the first to look past the nesting stage and determine survival of bluebirds after they leave the nest.

Fledgling Birds

While most golfers can identify the brilliantly colored adult bluebirds, fewer recognize the drab bluebird fledglings that emerge from the nest. Little is known about this life stage of bluebirds, as they are difficult to study due to their cryptic coloring and secretive behavior. Early research on other species showed that fledglings die primarily due to two causes – predation and starvation. Predation is common among young birds because they are not yet proficient at flying and depend almost entirely on their parents for protection. As they get older and reach independence from their parents, the common cause of death is starvation because many do not have the experience to successfully find enough food to sustain themselves (10).

More recently, researchers have become interested in the fledgling life stage because high mortality during the juvenile period can reduce population size (1). Survival can be influenced by many different factors, including body condition, food availability, habitat features, and weather (2, 5, 12). The habitat that a bird fledges into could impact their survival, as fledglings generally require complex vegetation structure to allow escape from predators (2, 5). In one case study, white-throated thrushes, relatives of the American robin, that fledged from nests in manicured coffee plantations in Costa Rica had lower survival than their counterparts that fledged from shrubby cow pastures (3). Because golf courses are generally manicured and offer less dense vegetation, we wanted to test if there was a difference in fledgling survival rates between golf course and non-golf habitats.

Site Selection

We worked on seven sites in the Williamsburg, Virginia area. We chose three local golf courses (all non-links style) and four non-golf sites (ranging from a college campus to a state park) typical of bluebird nesting habitat in the area. Eastern bluebirds used nest boxes at each site, facilitating easy monitoring. We determined nesting success on each site by checking each nest

Allyson Jackson is shown tracking bluebirds on a golf course in Williamsburg, Virginia. Small radio-transmitters are attached to the fledglings, which allows relocating them using the antenna shown here.

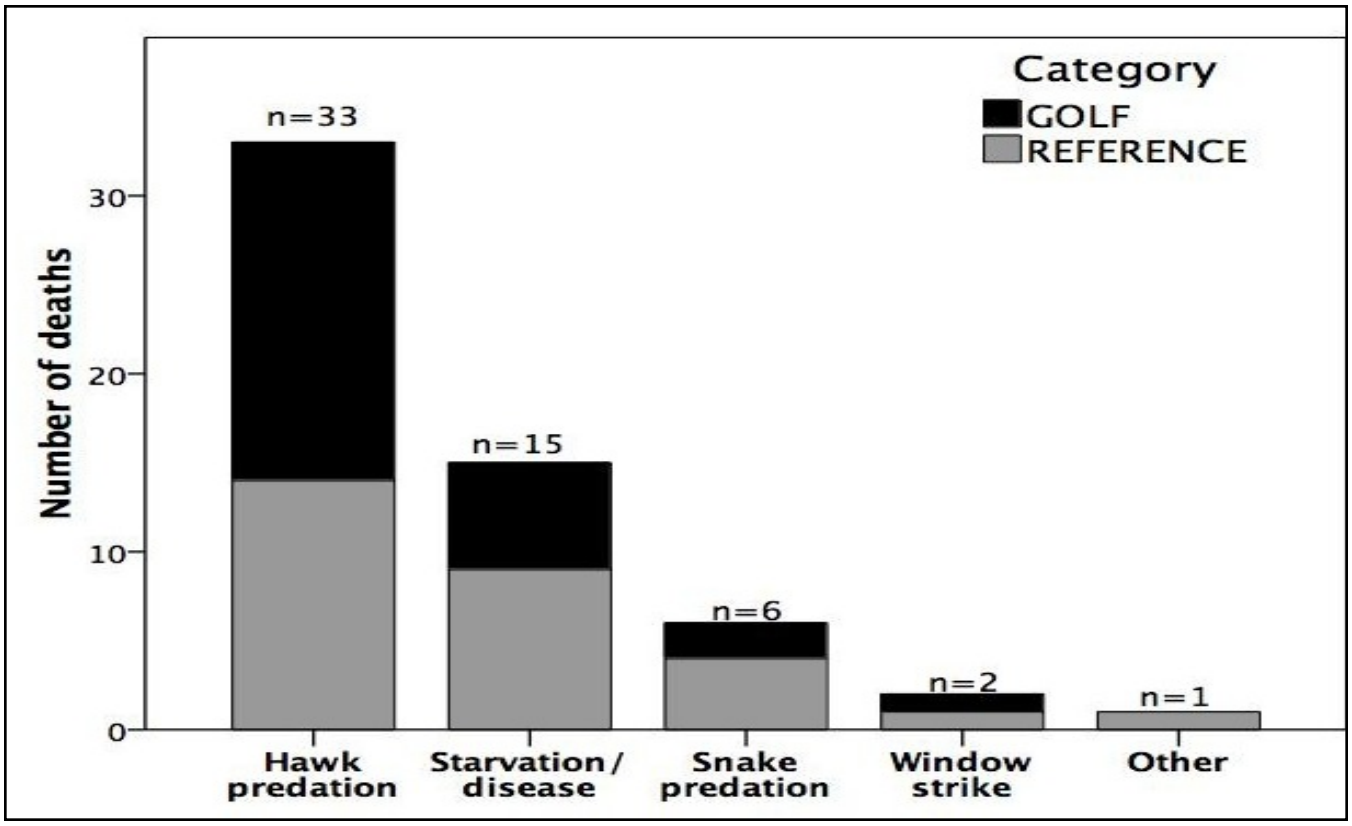

Figure 1. The majority of mortality, both on and off golf courses, was due to hawk predation. There are roughly equal proportions of each type of mortality on golf course and reference sites.

box weekly to determine how many eggs were laid and how many babies survived to fledge.

Tracking Survival with Radio-Telemetry

We used small radio-transmitters to track fledgling survival on golf courses in 2008 and 2009. These transmitters are designed so that they do not interfere with the bird's behavior, while allowing us to unobtrusively relocate the bird by using a tracking antenna. The transmitters weigh approximately 1 gram and are attached to the birds using an elastic harness while they are still in the nest. After the birds fledged naturally, we tracked survival of the birds for up to 40 days after they fledged by relocating them every other day. Every time a fledgling was found, we took a global positioning system (GPS) reading to document its location.

Using transmitters enabled us to document the cause of mortality in cases where a bird died before the end of the study, as transmitters were recovered with telltale clues. For instance, a transmitter found surrounded by feathers was evidence of hawk predation (because hawks pluck feathers before eating). On the other hand, when snake predation occurred we recovered a beeping snake that had ingested the transmitter along with our fledgling.

Causes of Mortality

We tracked 156 bluebird fledglings over the course of the study and documented 57 mortality events (Figure 1). Bluebird fledglings primarily died due to hawk predation, with a subset dying due to starvation or disease, snake predation, or window strikes.

Hawk predation is a common cause of death for many species of songbirds (1, 3, 8, 11, 12). Because bluebird fledglings are such weak flyers, it follows that they could be quick and easy sources of prey for raptors. We observed three species of raptor that could be responsible for the mortalities – red-shouldered hawks (*Buteo lineatus*), red-tailed hawks (*Buteo jamaicensis*), and the most likely culprit, Cooper's hawks (*Accipiter cooperi*). Cooper's hawks are specialists at song-

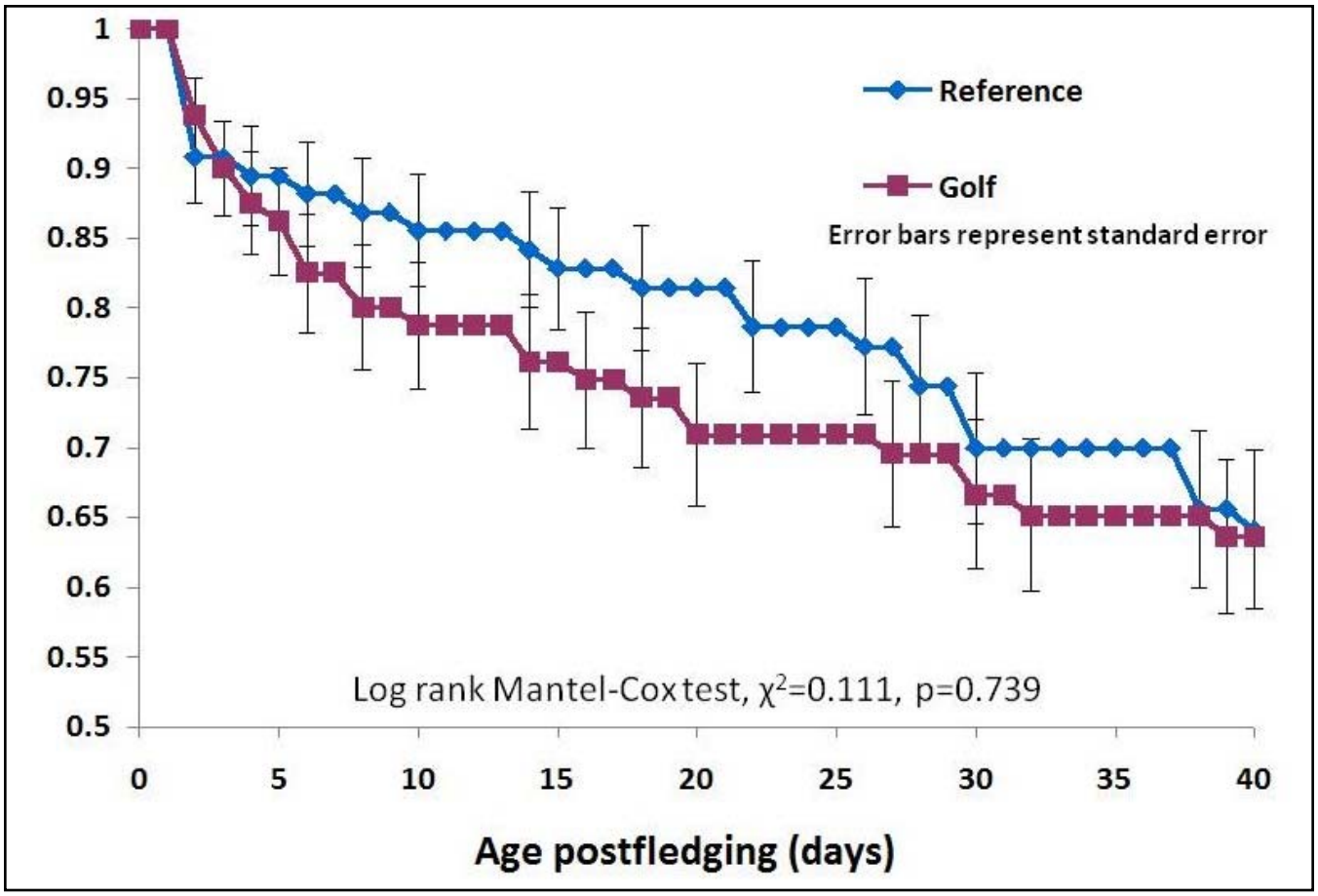

Figure 2. There was no difference in survival rates of fledglings (to 40-days postfledging) between golf course and reference sites.

bird predation and are raising their own nestlings at the time of year when we observed peak bluebird mortality (4). Growing raptor nestlings require a large and constant supply of food, and the hawks may be using bluebird fledglings to provision their young.

The second most common cause of death was starvation or disease, where we recovered the body of the fledgling still intact and attached to the transmitter. This cause of mortality was more common for older fledglings (after independence from their parents), consistent with other published research (10). We recorded six instances where fledglings were killed by snakes, either black rat snakes (*Elaphe obsoleta*) or black racers (*Coluber constrictor*)—both common edge specialists in Virginia. There does not appear to be a difference in causes of mortality between golf course and reference sites, indicating that similar predators are found on both types of habitat.

Survival Rates on Golf and Reference Sites

In terms of survival to 40-days postfledging, we detected no difference between golf course and reference sites, indicating that golf course fledglings did no worse than their reference counterparts (Figure 2). Both groups of fledglings averaged about 65% survival to 40-days postfledging. Many birds that fledged from golf courses, however, left the golf course environment at some point in their lives and moved to adjacent areas. Because of this, we are unable to conclude what would happen to these birds had they remained on the golf course for the rest of their lives. Our golf course sites are generally surrounded by suitable habitat, so we cannot comment on what would happen on golf courses in more urban landscapes where the birds do not readily find habitat nearby.

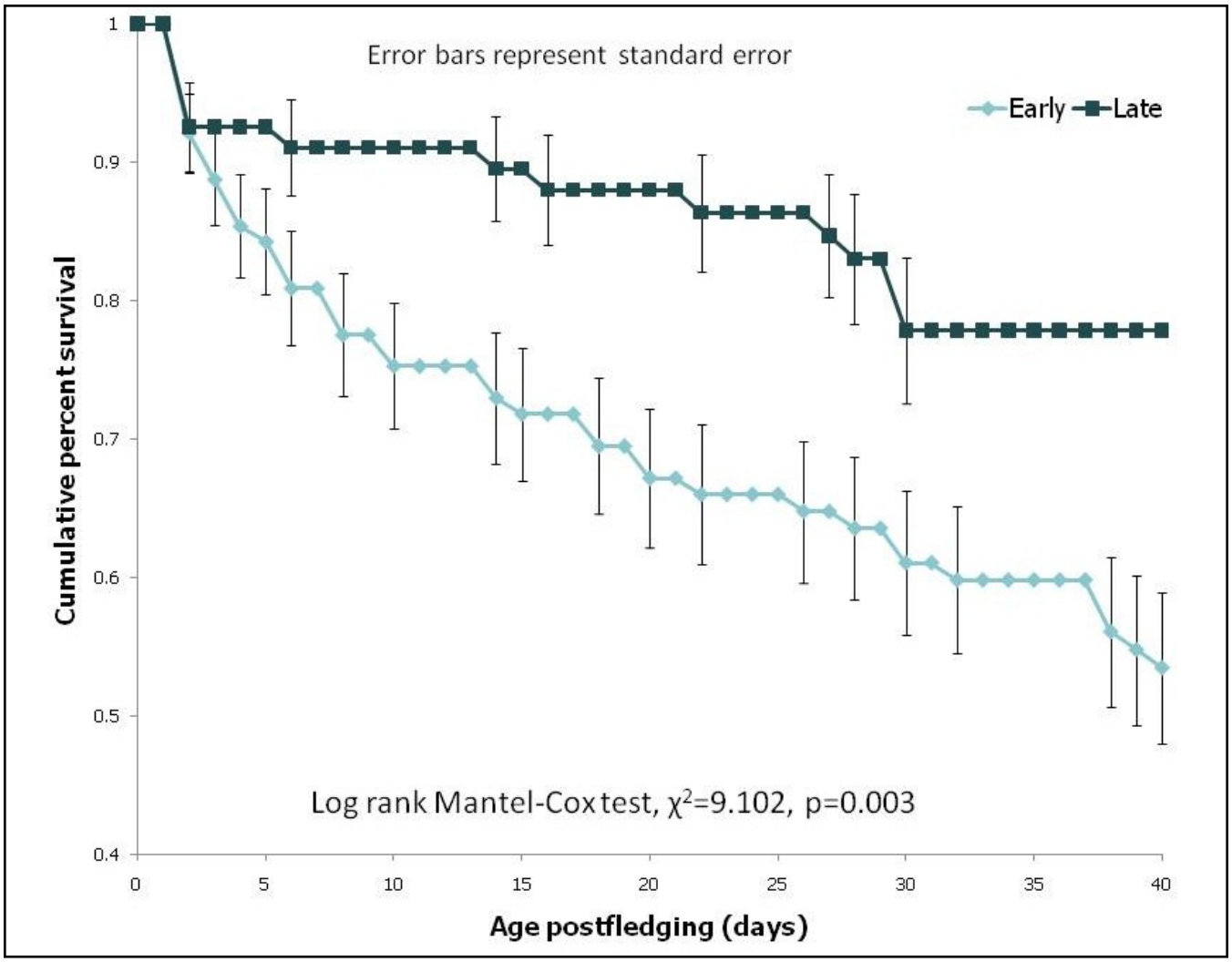

Figure 3. Survival rates of fledglings, compared between early and late fledging birds showed that birds that fledged later in the season were more likely to survive than those that fledged earlier.

Time of Year and Forest Cover Affect Survival

To understand better what factors could be affecting survival, we also used a Cox proportional hazards model to test what affects bluebird fledgling survival. This model allowed us to see which variables affect survival. We chose variables that we either hypothesized could affect survival (golf vs. nongolf, percent forest cover around nest boxes, transmitter weight) or have been found to affect fledgling survival in other studies (year of data collection, prefledging body condition, and fledging date). When we looked at other factors that may affect survival, we found that there was a large difference between the early and late portions of the breeding season (Figure 3). Birds that fledged early (May and June) were more likely to die than birds that fledged later (July and August). This could be due to the decrease in hawk predation later in the season. In the late summer months when raptors are no longer feeding their young, we saw a decrease in the number of hawk-related mortalities. Anecdotally, there also seemed to be a higher abundance of bluebirds' favored insect food later in the season which could help increase survival.

We also found (for both golf course and reference nests) the habitat around the nest box was an important determinant of early survival (up to 10 days postfledging). Immediately after fledging, most birds did not move far from their nest and so are constrained to whatever habitat was nearby. We found that fledglings were more likely to be killed by hawks if they fledged from

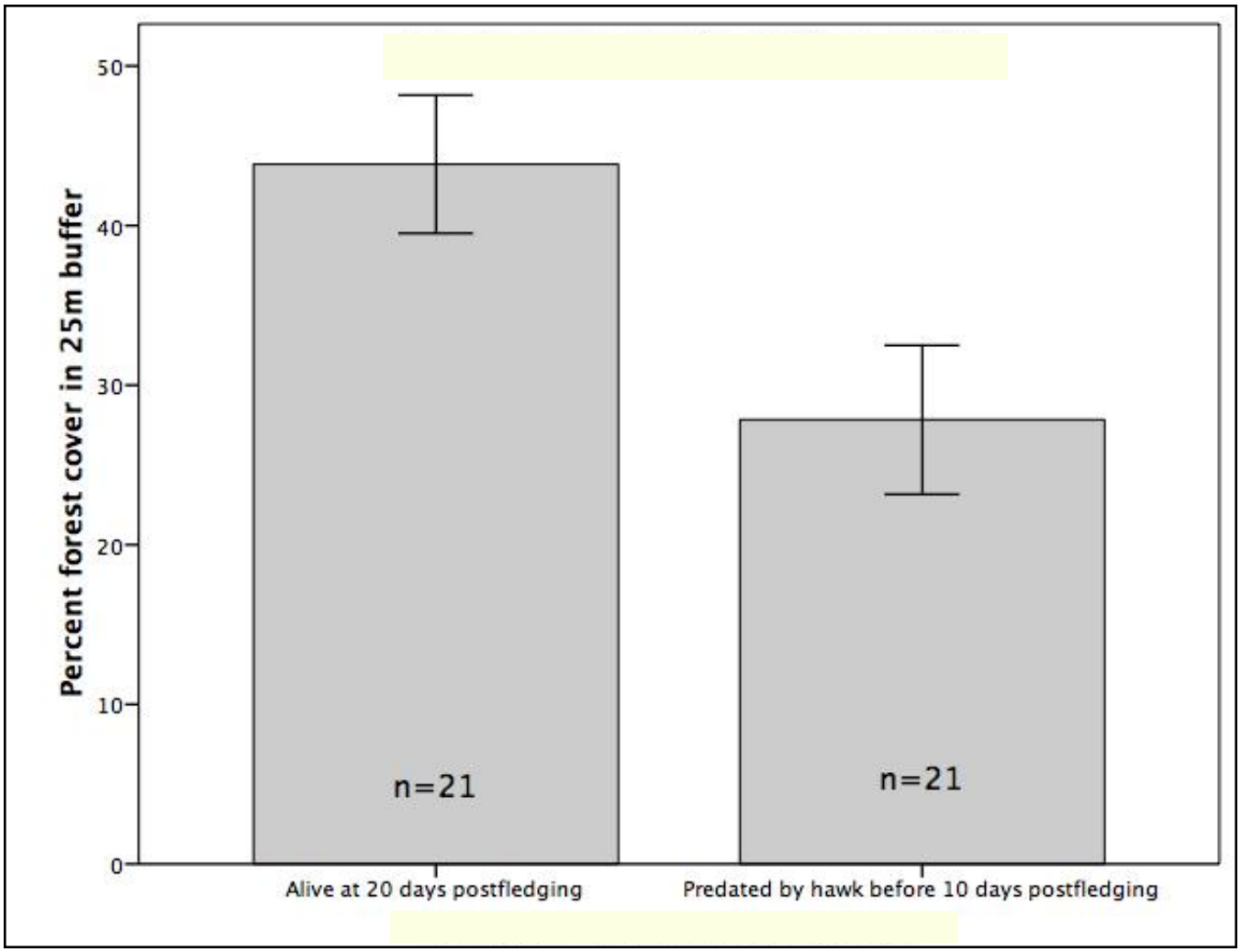

Figure 4. Quantifying forest cover around nest boxes and comparing birds that were predated by hawks before 10-days postfledging and those that survived showed that birds that survived came from boxes with more forest cover.

boxes surrounded by little or no forest cover. This makes sense, as fledglings generally leave the nest and immediately seek cover where they remain for several hours or days with their parents bringing them food and offering protection. If cover is not found near to the nest box, reaching safety requires a longer and more dangerous journey.

We compared nest boxes where birds had been predated by a hawk shortly after fledging (within 10 days) with boxes where the fledgling had survived to at least 20 days postfledging. When the amount of forest cover between these two sets of boxes was compared, we found that birds that survived had significantly more forest cover around their nest box than those that were killed (Figure 4).

Conclusions

This study is the first to document that bluebird fledglings on golf courses do no worse than their reference counterparts despite the potential threats of human disturbance, pesticides, and intensive turf management. Our data also provide for implementation of easy and sound conservation strategies for helping bluebirds on all heavily manicured sites—be it a golf course or a city park. By placing nest boxes in areas where there is sufficient forest cover with undergrowth, we can significantly improve survival of fledgling bluebirds during their most vulnerable early weeks of independence.

Acknowledgements

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