Success and Predation of Bird Nests in Grasslands at Valley Forge National Historical Park

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Success and Predation of Bird Nests in Grasslands at Valley Forge National Historical Park

Les Murray*

Abstract - Populations of grassland birds are declining in the Northeast due to habitat loss and fragmentation. Fragmentation of grasslands can contribute to lower breeding success of grassland birds by altering local predator communities. Using miniature video cameras, I estimated nest success and identified nest predators in grassland fragments at Valley Forge National Historical Park in southeastern Pennsylvania. Estimated nest-success probability for *Sturnella magna* (Eastern Meadowlark) at Valley Forge was 0.25 (0.04–0.65, n = 7) and similar to estimates from the Midwest, but slightly lower than other studies in the Northeast. Nest success for *Spizella pusilla* (Field Sparrow; 0.77 [0.31–0.98, n = 8]) and *Agelaius phoeniceus* (Red-winged Blackbird; 0.48 [0.18–0.80, n = 10]) was higher than estimates from other studies. The local predator community identified at Valley Forge was less diverse than documented in other studies, with only 4 species depredating 8 of 25 monitored nests. The primary predator was *Odocoileus virginianus* (White-tailed Deer; 38% of nest predation events) followed by *Vulpes vulpes* (Red Fox; 25%), *Procyon lotor* (Raccoon; 13%), and a probable *Mustela* sp. (weasel; 13%). I never detected nest predation by small mammals or snakes, which are important nest predators in the Midwest. The impact of White-tailed Deer on grassland birds at Valley Forge is uncertain, therefore further research is needed to fully understand local predator–prey community dynamics.

Introduction

Grassland-bird populations are declining throughout North America (Sauer et al. 2014). In the Northeast (New England and Mid-Atlantic states), 56% of grassland-breeding species have significantly declined in abundance since their populations were first monitored in 1966 (Sauer et al. 2014). Population declines in the Northeast are associated with loss of grassland habitat due to succession to woodland habitat, changes in agricultural practices, and human development (Murphy 2003, Perlut 2014, Vickery and Dunwiddie 1997). Grassland habitat in New England and New York has declined by 60% since the 1930s (Vickery et al. 1994).

In addition to a reduction in available breeding areas, habitat loss leads to fragmentation of habitats resulting in smaller grasslands and more habitat edge. Increased predation in smaller fragments and near edges has been reported in other studies (Balent and Norment 2003, Gates and Gysel 1978, Herkert et al. 2003, Johnson and Temple 1990, Winter and Faaborg 1999, Winter et al. 2006). Several proposed hypotheses explain increased predation near edges including increased predator activity or abundance near edges (Faaborg et al. 1995, Johnson and Temple 1990) and greater predator-species richness in edge habitats (Heske 1995, Vander

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Haegen and Degraaf 1996). However, the effects of fragmentation on nest predation vary depending on the local predator community (Chalfoun et al. 2002, Heske et al. 2001, Tewksbury et al. 1998). Thus, identification of local nest predators is important to understanding causes of nest failure in fragmented landscapes (Heske et al. 2001, Thompson and Ribic 2012). Several studies have used video cameras to investigate patterns of grassland-nest predation in the Midwest and Great Plains (see Ribic et al. 2012b), but predators of grassland bird nests in the Northeast have not been documented using video recording.

I monitored nests of *Sturnella magna* L. (Eastern Meadowlark), *Spizella pusilla* Wilson (Field Sparrow), and *Agelaius phoeniceus* L. (Red-winged Blackbird) in restored grasslands in Valley Forge National Historical Park (hereafter Valley Forge) in southeastern Pennsylvania in 2011 and 2012. One objective of my study was to estimate nesting success in Valley Forge to compare with estimates in other studies in the Northeast and Midwest. The second objective was to identify predators of grassland-bird nests using miniature video cameras.

**Field-Site Description**

Valley Forge park (1293 ha) is a mixture of forests and fields, including grassland habitat (541 ha), surrounded by residential development and roads. Valley Forge is managed to preserve the natural and cultural resources of the area and is one of the few large, contiguous, protected areas in southeastern Pennsylvania. Valley Forge is located in Chester and Montgomery counties within the Northern Appalachian Piedmont ecological region. The long-term average temperature during May and June for the area is 20 °C, with 18.1 cm of precipitation on average during the 2-month period (NOAA National Climatic Data Center 2013).

Prior to the breeding season, grasslands within the park are maintained by annual mowing to maintain the appearance of small-grain agriculture that was present on the landscape during the late 18th Century. The grassland areas are dominated by non-native grass species; *Festuca rubra* L. (Red Fescue) and *Festuca pratensis* Huds. (Meadow Fescue) are the most widespread grasses. Native warm-season grass species (e.g., *Andropogon* L. spp. [bluestems]) are less abundant. Maintenance of areas of *Rubus cuneifolius* Bailey (Sand Blackberry), a state-endangered plant in Pennsylvania, create a shrub component within some grasslands. In addition, invasive vines and shrubs (i.e., *Celastrus orbiculatus* Thunb. [Oriental Bittersweet] and *Lonicera japonica* Thunb. [Japanese Honeysuckle]) are found in many grasslands at Valley Forge.

**Methods**

We searched for nests in 6 grassland patches (min–max = 24 –75 ha) at Valley Forge during May and June of 2011 and 2012. Typically, 2 researchers conducted nest searches each day using random walks and behavioral cues with variable effort in patches based on bird abundance and activity. The grassland-bird community at Valley Forge predominantly consisted of Eastern Meadowlarks, Field Sparrows, and Red-winged Blackbirds (Murray 2014a). Nest-searching effort was directed
towards Eastern Meadowlarks and Field Sparrows because these were species of conservation concern that commonly nested at Valley Forge. Researchers recorded nest locations using a handheld GPS, marked nests with a surveyor flag placed 5 m from the nest, and monitored the nests every 3 days.

Nests were continuously recorded using video equipment similar to Ribic et al. (2012a) and following the recommendations of Richardson et al. (2009). Researchers placed a miniature (3 cm x 10 cm) weatherproof infrared digital video camera near most nests within 3 days of finding the nest. Cameras were mounted on wooden stakes (30–90 cm above the ground) and placed approximately 30 cm from the nest. The camera was connected by a 20-m cable to a waterproof-cased portable DVR that constantly recorded digital video. The camera and DVR were powered by a 12-V sealed lead–acid battery. We painted the camera casings, stakes, waterproof cases, and batteries with a flat green paint to decrease visibility (Herranz et al. 2002). To conceal them from predators and park visitors, we placed cameras and stakes below the height of the vegetation surrounding the nest and covered the cable with grass and litter. A researcher visited the nest every 3 days to change the memory card and battery.

All Field Sparrow and Eastern Meadowlark nests were equipped with a video camera as soon as possible, but two Field Sparrow nests fledged young before a camera could be installed. Approximately half of the Red-winged Blackbird nests found were not monitored by cameras to increase the number of nesting intervals without cameras for estimation of the effects of cameras on daily nest success. We chose Red-winged Blackbird nests for our examination of camera effects because they were abundant. We maximized the number of Eastern Meadowlark and Field Sparrow nests equipped with cameras in order to identify predators of species of management concern. We reviewed captured video to determine if each nest fledged young or was depredated and to identify nest predators.

Apparent nest success (proportion of successful nests) is reported for each species for comparison to other studies. However, apparent nest success can be a misleading metric of reproductive success because nests that are active longer (i.e., successful) are more likely to be found. Thus, I also estimated daily nest survival by using the logistic exposure method (Shaffer 2004) in R (R Core Team 2013) for each species. Effects of cameras on Red-winged Blackbird nest survival were tested by comparing a model including a variable for presence or absence of a camera during a nesting interval with an intercept-only model using Akaike’s information criterion corrected for small sample size (AICc) (Burnham and Anderson 2002). In addition, profiled log-likelihood 95% confidence intervals for the estimated coefficient for camera effects were examined to determine if the interval included zero. Red-winged Blackbird daily nest survival was calculated for nests with and without cameras separately only if the model with camera effects had a lower AICc score than the null model and the confidence interval for camera effects excluded zero. The low number of nest-check intervals without cameras for Eastern Meadowlark nests (7 intervals) and Field Sparrow nests (9 intervals) did not allow for evaluation of camera effects for these species. Nest success for the entire nesting period was estimated by raising daily nest survival to the exponent of the typical number of
days in the nesting cycle (incubation and nestling) reported in the literature for each
species (Eastern Meadowlark = 24.5 days, Field Sparrow = 19 days, Red-winged
Blackbird = 24.5 days; Carey et al. 2008, Jaster et al. 2012, Yasukawa and Searcy
1995, respectively).

Results

We found a total of 26 nests, but one Red-winged Blackbird nest was abandoned
and not considered in our analyses. We monitored 7 Eastern Meadowlark nests for
a total of 76 days with cameras at nests for 80% of the active nesting days, 8 Field
Sparrow nests for a total of 73 days with cameras at nests for 68% of the days, and
10 Red-winged Blackbird nests for a total of 140 days with cameras at nests for 35%
of the days. Apparent nest success for all nests was 0.42.

We did not detect effects of cameras on nesting success in the logistic exposure
analysis for Red-winged Blackbirds (n = 49 nest-check intervals). The AICc values
were less for the camera-effects model than the null model (camera model: AICc
= 28.63, null model: AICc = 29.39), but the 95% confidence interval for the coef-
ficient of camera effects included zero (-4.85, 0.26), therefore daily nest survival
was calculated independent of the presence of cameras. Daily nest survival and
nest-success estimates from logistic exposure models were highest for Field Spar-
row and lowest for Eastern Meadowlark (Table 1). Uncertainty in estimates of daily
nest survival and overall nest success was high for all 3 species (Table 1). Nest-
success estimates for the entire nesting period from the logistic exposure model
were 13–42% lower than apparent nest success (Table 1). All nest failures were a
result of predation; brood parasitism was not observed for nests of any species.

Predation events were video recorded for 7 of the 9 nests that failed. In addition,
video evidence of a partial nest predation was recorded at a Field Sparrow nest that
fledged a single young. All predator visits except one were by mammals and oc-
curred between 2203 and 0437. Odocoileus virginianus Zimmermann (White-tailed
Deer) depredated 3 nests (38% of depredated nests where the predator was identi-
fied) and were the most common nest predator. White-tailed Deer depredated all
5 eggs from an Eastern Meadowlark nest, all but 1 egg from a Field Sparrow nest,
and 4 five-day-old nestlings from another Field Sparrow nest. Nestlings and eggs

<table>
<thead>
<tr>
<th>Species</th>
<th>Apparent nest success (n)</th>
<th>Intervals</th>
<th>Daily survival rate (95% CI)</th>
<th>Nest success (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern Meadowlark</td>
<td>0.43 (7)</td>
<td>30</td>
<td>0.9443 (0.8752–0.9824)</td>
<td>0.25 (0.04–0.65)</td>
</tr>
<tr>
<td>Field Sparrow</td>
<td>0.88 (8)</td>
<td>28</td>
<td>0.9861 (0.9403–0.9992)</td>
<td>0.77 (0.31–0.98)</td>
</tr>
<tr>
<td>Red-winged Blackbird</td>
<td>0.60 (10)</td>
<td>49</td>
<td>0.9706 (0.9329–0.9908)</td>
<td>0.48 (0.18–0.80)</td>
</tr>
</tbody>
</table>

Table 1. Apparent nest success (the proportion of nests that successfully fledged at least one young) and estimated nest success from logistic exposure models for grassland bird nests at Valley Forge National Historical Park in southeastern Pennsylvania in 2011 and 2012. Intervals = the number of nest-check intervals used in the logistic-exposure model. Nest success was estimated by raising the DSR to the number of days in the entire nesting cycle for the species.
from 2 Eastern Meadowlark nests (25% of depredated nests) were depredated by *Vulpes vulpes* L. (Red Fox). *Procyon lotor* L. (Raccoon) depredated 3 four-day-old Red-winged Blackbird nestlings. Six-day-old Eastern Meadowlark nestlings were depredated, but the predator knocked over the camera while pursuing the adult bird, thus precluding collection of conclusive evidence for identification; the triangular-shaped head and small black eyes with no eye-shine were suggestive of a *Mustela* L. sp. (weasel). In addition, a female Red-winged Blackbird committed infanticide of a lone 5-day-old Red-winged Blackbird nestingling (Murray 2014b). We were unable to identify a predator that knocked over the camera before depredating a Red-winged Blackbird nest.

**Discussion**

Estimates of nest success for grassland birds in Valley Forge were similar or higher than those reported in other studies. Eastern Meadowlark nest success was lowest among the species observed in this study, but was similar to estimates from the Midwest (Granfors et al. 1996, Lanyon 1957, McCoy et al. 2001, Rahmig et al. 2008, Ribic et al. 2012a, Roseberry and Klimstra 1970, Winter and Faaborg 1999). McCoy et al. (1999) estimated that nest survival of 0.30 was sufficient to maintain a population of Eastern Meadowlarks in Missouri Conservation Reserve Program. Therefore the estimated 0.25 nest success at Valley Forge is near levels needed to maintain a stable population, but estimates of fledgling survival at Valley Forge are necessary to calculate overall reproductive success. Our small sample size for Eastern Meadowlark nests and uncertainty in the estimate warrant caution in concluding that Valley Forge is a source habitat. Estimates of Eastern Meadowlark nest success in other areas in the Northeast were higher than those documented during this study (0.46 in New York [Norment et al. 2010], 0.70 in West Virginia [Warren and Anderson 2005]). Eastern Meadowlark nest success at Valley Forge could be negatively impacted by the local predator community (e.g., high White-tailed Deer density), greater urbanization, or smaller patch sizes causing lower nest success at Valley Forge than was estimated in New York and West Virginia.

Red-winged Blackbird nest success in grasslands at Valley Forge was higher than estimates reported for other upland habitats. No impact of the presence of a camera on nest survival was found in this study, but the confidence interval was skewed toward a negative effect of cameras at nests. Nest survival for the entire nesting period ranged from 0.15 to 0.39 for Red-winged Blackbird populations in the Midwest and Northeast (Blakely 1976; Camp and Best 1994; McCoy et al. 1999, 2001; Patterson and Best 1996; Robertson 1972; Warren and Anderson 2005) compared with 0.48 for Valley Forge. Brood parasitism by *Molothrus ater* Boddaert (Brown-headed Cowbird) was a substantial contributor to nest failure for Red-winged Blackbirds in most populations, with up to 25% of nests parasitized in Conservation Reserve Program fields in Iowa (Patterson and Best 1996). The proportions of Red-winged Blackbird nests that failed due to predation, however, were similar between Valley Forge (0.40) and fields in Connecticut (0.30; Robertson 1972), when nests that were abandoned with eggs were excluded.
Field Sparrow nest success was the highest among the 3 species monitored in this study and higher than estimates in other studies. Nest-survival estimates ranged from 0.10 to 0.47 for studies in Illinois, Missouri, and Wisconsin (Best 1978; Burhans et al. 2002; McCoy 1999, 2001; Thompson and Burhans 2003; Vos and Ribic 2013), but brood parasitism was a contributing factor to nest failure in these other studies that was not observed at Valley Forge. Nest-predation rates away from edges in Michigan (0.05–0.10) were similar to those observed in our study (0.12), but were higher near edges (0.40–0.50) (Gates and Gysel 1978). Variation in predation rates among studies likely is driven by local predator communities; Best (1978) and Thompson et al. (1999) both identified snakes as frequent predators of Field Sparrow nests, but snakes were not observed depredating nests in Valley Forge.

Fewer nest-predator species were identified in Valley Forge than in other studies using video cameras to identify grassland-nest predators. At least 10 species were identified depredating nests in each of 4 studies in the Midwest (Pietz and Granfors 2000a, Renfrew and Ribic 2003, Ribic et al. 2012a, Thompson et al. 1999) compared to 4 species identified in this study (including the unconfirmed Mustela sp.). Overall, video evidence of nest predation by at least 18 mammal species, 7 bird species, and 5 snake species were reported in the Midwest (Pietz et al. 2012). All 4 predator species identified in this study have depredated nests in other studies; infanticide by Red-winged Blackbirds had not been previously recorded (see Murray 2014b for a detailed description). The small number of predation events recorded by video surveillance at Valley Forge partially explains the low diversity of predators detected, and I would expect additional predator species (e.g., snakes, birds) to be identified with further nest monitoring.

The predominance of mammalian nest predators in Valley Forge parallels nest predation in other studies (e.g., Pietz and Granfors 2000a, Ribic et al. 2012a), but small-mammal predators were more common in the Midwest (Pietz et al. 2012). Valley Forge, however, is outside of the range of Ictidomys tridecemlineatus Mitchell (Thirteen-lined Ground Squirrel), which is the most common small-mammal predator in the Midwest (Grant et al. 2006, Pietz and Granfors 2000a, Ribic et al. 2012a). Several snake species known to depredate nests (e.g., Coluber constrictor L. [North American Racer], Lampropeltis triangulum Lacépède [Milk Snake], and Thamnophis sirtalis L. [Common Garter Snake]) occur at Valley Forge (Tiebout 2003) but were not detected in this study. Predators of grassland-bird nests in the Northeast had not been previously identified using video cameras, and thus, comparison of predator communities within the Northeast is not possible.

Nest predation (0.38) by White-tailed Deer at Valley Forge was higher than reported from other studies (Grant et al. 2006 [0.07], Ellison et al. 2013 [0.05], Pietz and Granfors 2000b [0.08]). Because nest predation by White-tailed Deer is thought to occur opportunistically (Pietz and Granfors 2000b), the relatively high density of White-tailed Deer at Valley Forge (70 per km², National Park Service 2009) likely contributed to the high rate of nest predation by White-tailed Deer. In addition, competition for food among White-tailed Deer in a high-density situation might make it more likely for these animals to consume high-protein, calorie-dense foods such as eggs and chicks when opportunities occur. In the fall of 2010, the
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National Park Service implemented a plan to reduce the White-tailed Deer population because of the negative effects of high densities on forest regeneration in the park (National Park Service 2009). I would expect less nest predation by White-tailed Deer following herd reduction. However, the overall effects of White-tailed Deer removal on nest success is difficult to predict because it is possible that nest predation is compensatory and thus, reduction of one nest predator might allow opportunities for other predators and not affect overall nesting success (Ellis-Felege et al. 2012, Ellison et al. 2013). A comparison of the nest-predator community before and after reduction of the White-tailed Deer herd would provide insight into potential compensatory shifts in nest-predation risk among predators at Valley Forge and potentially give insight on how White-tailed Deer grazing on vegetation influences nest success.

In conclusion, nest success for Eastern Meadowlarks, Field Sparrows, and Red-winged Blackbirds at Valley Forge was similar to reported nest success from other studies. The diversity of nest predators in Valley Forge is lower than those reported in other studies, but continued sampling likely would increase the number of nest-predator species documented because several unconfirmed potential nest predators occur in Valley Forge (e.g., birds and snakes). Previous conclusions about grassland-nest predators in the Northeast were based on likely predators in the area and predator activity or cues at the nest (e.g., Ardizzone and Norment 1999, Vickery et al. 1992). Video evidence, however, has shown that nests are depredated by diverse species and that cues at the nest cannot be used to accurately identify nest predators (Pietz and Granfors 2000a, Thompson et al. 1999). Therefore, continued research on local predator communities in grasslands of the Northeast is important for better understanding factors that can affect the stability of grassland-bird populations and managing habitat in the region.

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