DO PREDATION RATES ON ARTIFICIAL NESTS ACCURATELY REFLECT PREDATION RATES ON NATURAL BIRD NESTS?

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Abstract.—Artificial nests are widely used in avian field studies. However, it is unclear how well predation rates on artificial nests reflect predation rates on natural nests. Therefore, we compared survival rates of artificial nests (unused natural nests baited with House Sparrow eggs) with survival rates of active bird nests in the same habitat at the same sites. Survival rates of artificial nests (27.7%) were significantly lower than nest survival rates of natural nests (58.6%). Logistic regression analysis indicated that the inclusion of an index of nest concealment in addition to nest type (natural or artificial) significantly increased the amount of the variability in nest predation accounted for by the regression. However, because the relationship between nest survival and nest type (natural or artificial) was still highly significant even with nest concealment included in the model, we conclude that higher rates of nest predation on artificial nests were not entirely due to the greater conspicuousness of artificial nests. We suggest that lack of parental defense is an additional contributing factor responsible for higher predation rates on artificial nests and, therefore, is likely to be a potential confounding factor in future nest predation experiments using artificial nests.

ES ACASO LA TASA DE DEPREDACIÓN EN NIDOS ARTIFICIALES UN REFLEJO DE LA TASA DE DEPREDACIÓN EN NIDOS NATURALES?

Sinopsis.—Los nidos artificiales son ámpliamente utilizandos en trabajos de campo. Sin embargo, no esta claro si la tasa de depredación en nidos artificiales es un reflejo de la tasa de depredación en nidos naturales. Por consiguiente, comparamos la tasa de supervivencia en nidos artificiales (nidos naturales sin utilizar en donde se colocaron huevos de gorrión inglés) con la tasa de supervivencia de nidos activos en las mismas localidades y en el mismo tipo de habitat. El éxito de supervivencia de nidos artificiales (27.7%) fue significativamente menor que la supervivencia de nidos naturales (58.6%). Un análisis de regresión logística indicó que el incluir un índice de inconspicuidad, en adición al tipo de nido (natural o artificial), incrementó significativamente la cantidad de variabilidad de la depredación de nidos contabilizados para la regresión. Sin embargo, debido a que la relación entre la supervivencia y el tipo de nido todavía era altamente significativa (inclusive incluyendo el grado de inconspicuidad en el modelo), concluimos que la alta tasa de depredación en nidos artificiales no se debe en su totalidad al grado de conspicuidad de dichos nidos. Sugerimos que la ausencia de defensa parental o de la hembra en el nido con su plumaje críptico, puedan ser una contribución adicional responsable para la mayor tasa de depredacion en nidos artificiales.

The use of artificial nests provides a potentially valuable technique for determining predation rates on natural nests. Artificial nests are relatively easy to use compared to the monitoring of natural nests and lend themselves readily to experimental manipulation. However, a review of approximately 80 experiments using artificial nests cited the failure of artificial nests to correspond to the systems they attempt to model as an important reason for researchers to be skeptical of the assumption that predation rates on artificial nests reflect predation rates on natural nests (Major and Kendall 1996). For example, predation rates on artificial nests baited with *Coturnix* quail eggs may not provide a valid index to predation rates on natural nests because quail eggs are much larger than most passerine eggs, and are less invulnerable to predation by many common nest predator species (Boag et al. 1984, Roper 1992, Haskell 1995, DeGraaf and Maier 1996). Furthermore, the appearance of wicker or bamboo nests used in many studies may influence nest predation rates (Martin 1987). In addition, researchers often fail to deploy artificial nests with the same spacing, microhabitat, and monitoring protocol as natural nests (Major and Kendall 1996). Finally, predation rates may differ between natural and artificial nests because of odors associated with egg decay (Henry 1969).

The adoption of new protocols on the deployment of artificial nests may help minimize the bias associated with estimating predation rates with artificial nests (Major and Kendall 1996). However, predation rates may still be affected by the presence of parent birds because nest defense by the adults deters predators (Montgomerie and Weatherhead 1988), the movements of the adults facilitate the location of the nest by nest predators (Skutch 1947), or the presence of incubating parent birds conceals the eggs (Martin 1993). Therefore, there remain reasons to believe that there is a limit to the degree to which artificial nests can mimic natural nests.

In this study, we compared predation rates on artificial and natural nests. However, we controlled for many of the factors that are potentially responsible for previously reported differences between predation rates on artificial and natural nests, including egg size, nest type, and human disturbance. In addition, we compared nest predation rates on artificial nests between the early and late portions of the exposure period to test for increases in predation rates associated with egg decay. Because of their economy and versatility, the use of artificial nests in avian biology will likely continue, making information on biases associated with this technique vital to the interpretation and evaluation of the results of these future studies.

METHODS

This study was conducted in two 10-ha clearcuts in the White Mountain National Forest, New Hampshire (44°03′N, 71°15′W). Clearcuts were 9 yr post-cutting at the time of the study and were similar to each other in plant structure and species composition. Because nest appearance is

known to affect predation rates on artificial nests (Martin 1987), we used artificially baited natural nests (hereafter artificial nests) in this study. Nests of Chestnut-sided Warblers (*Dendroica pensylvanica*), American Redstarts (*Setophaga ruticilla*), Swainson's Thrushes (*Catharus ustulatus*), Veerys (*Catharus fuscesens*) and Alder Flycatchers (*Empidonax alnorum*) were found by following adult birds with nesting material, or by systematic searching. House Sparrow (*Passer domesticus*) eggs were collected earlier in the season, and stored in a 10% sodium silicate solution and refrigerated immediately after collection to preserve freshness. Although Sodium silicate imparts no discernable taste or odor to avian eggs (Romanoff and Romanoff 1949), we rinsed eggs in spring water prior to deployment. Artificial nests had been collected during the previous breeding season and stored overwinter in cardboard boxes in an office storage area away from any obvious source of strong odors. Before use, artificial nests were aired for several days outside. We wired artificial nests in place in shrubs or saplings in nest sites typical of those used by the species for which we found natural nests (see Results). We baited each nest with a single House Sparrow egg, marked the nest with red flagging 3–5 m distant, and checked the nest every 3–5 d in a manner identical to that used to monitor natural nests. Artificial nests were deployed 23 Jun.–10 Jul. 1997, and were exposed for 10 d on average (SE = 0.84). Rubber gloves were worn to conceal human scent; however, rubber boots were not used because rubber boots were not used when visiting natural nests.

To control for the effect of nest microhabitat variables on the survival of artificial and natural nests, we measured the height of the nest from the nest rim to the ground, as well as nest conspicuousness. Nest conspicuousness was measured by estimating the percent of the nest visible (to the nearest 5%) from a distance of 1 m from the four cardinal directions and from directly above the nest. All five measurements were averaged to produce a single estimate of nest conspicuousness for each nest. All conspicuousness estimates were made by a single observer. We calculated nest survival rates using the Mayfield (1975) estimator and raised them to the 15th power to yield the probability of a nest surviving through laying and incubation (3 days laying and 12 days incubation). In addition, we tested for the effects of egg decay on predation rates of artificial nests by comparing nest survival rates between the early half and the later half of the nest exposure period. Nest survival rates were compared between artificial and natural nests, and between the early and late portions of the exposure period, following Sauer and Williams (1989). Nest height and nest conspicuousness were compared between artificial and natural nests using two-sample t-tests. We tested for relationships among nest survival, nest type (natural versus artificial), and nest conspicuousness using logistic regression (Hosmer and Lemeshow 1989) and evaluated the contribution of the independent variables to the overall r^2 or the regression using multiple-partial F-tests (Kleinbaum and Kupper 1978). Regressions included a nest type$^\times$ nest conspicuousness interaction term.

TABLE 1.   Mean nest survival rates, nest height and nest conspicuousness (± 1 SE) of natural
           and artificial nests on the White Mountain National Forest, New Hampshire, 1997.

	Natural ($n = 22$)	Artificial ($n = 30$)
Nest survival	58.6(1.66)	27.7(2.90)
Nest height (cm)	93.3(7.77)	97.0(5.41)
Nest conspicuousness (average percent visible)	15.0(2.57)	31.0(2.81)

RESULTS

Twenty-two natural nests of five different species (Chestnut-sided War-bler, $n = 16$; American Redstart, $n = 2$; Swainson's Thrush, $n = 1$; Veery, $n = 1$; and Alder Flycatcher, $n = 2$) and 30 artificial nests were included in the analyses. Nest survival rates did not differ between the two plots for artificial nests ($\chi^2 = 0.04$, df = 1, $P = 0.85$), or natural nests ($\chi^2 = 0.88$, df = 1, $P = 0.35$) so data from both plots were pooled for further analyses. Nest survival rates were significantly lower for artificial nests than natural nests ($\chi^2 = 4.57$, df = 1, $P = 0.03$; Table 1). Nest height did not differ between artificial and natural nests ($t = 0.40$, df = 34, $P = 0.70$; Table 1), however, nest concealment was significantly greater for natural nests ($t = 4.07$, df = 35, $P < 0.001$; Table 1). Survival rates of artificial nests did not differ between the early and late portions of the exposure period (27.3% and 25.6%, respectively; $\chi^2 = 0.00$, df = 1, $P = 1.00$).

Results of the logistic regression analysis indicated that the probability of predation was higher for artificial nests than for natural nests (Table 2), and the regression model incorporating nest type and nest conspic-uousness accounted for 34% of the variation in nest survival. Although the regression coefficient describing the relationship between nest sur-vival and nest conspicuousness did not differ statistically from zero (Table 2), nest conspicuousness accounted for 13% of the variability in nest pre-dation explained by the regression, and a multiple-partial F-test indicated this contribution was statistically significant ($F_{1,36} = 6.90$, $P = 0.03$). There was no significant interaction between nest type and nest conspicuousness ($P > 0.26$) indicating that the relationship between nest survival and nest concealment was the same for both natural and artificial nests.

TABLE 2.   Results of logistic regression of nest survival on nest type (natural versus artificial)
           and nest conspicuousness of 22 natural and 30 artificial nests on the White Mountain
           National Forest, New Hampshire, 1997.

	Estimate	SE	χ^2	P
Intercept	0.90	0.93	0.94	0.33
Nest type	1.12	0.46	5.81	0.016
Nest conspicuousness	0.056	0.038	2.15	0.14

DISCUSSION

Survival rates of artificial nests in this study were lower than survival rates of natural nests, a result that is consistent with the results of other studies comparing predation rates between natural and artificial nests (Major and Kendall 1996, Wilson et al. 1998). Artificial nests were also less concealed than natural nests. Numerous studies have reported a positive relationship between nest survival and nest concealment (e.g. Nolan 1978, Best and Stauffer 1980, Peterson and Best 1985, Martin and Roper 1988, Norment 1993). Therefore, it is possible that higher predation rates on artifical nests are simply the result of the greater conspicuousness of artificial nests. Although the inclusion of nest conspicuousness in the present study significantly increased the amount of variability in nest survival explained by the regression, nest type was significantly related to nest survival even with nest conspicuousness included in the regression. Thus, lower survival rates of artificial nests appear to be attributable to some other quality of artificial nests in addition to their greater conspicuousness.

The deposition of human scent (Whelan et al. 1994) or odors associated with egg decay (Henry 1969) could potentially have contributed to the higher predation rates on artificial nests that we observed. However, there were no differences between natural and artificial nests in rates of visitation or deposition of human scent during the nest exposure period. Furthermore, we observed no difference between nest survival rates of artificial nests during the early and late periods of nest exposure. Thus, we conclude that deposition of human scent or the presence of odors associated with egg decay are unlikely explanations for the higher rates of nest predation we observed on artificial nests. An alternative explanation is that nest predators may be deterred from natural nests by the presence of parent birds, either through active defense (Montgomerie and Weatherhead 1988), or because incubating females increase concealment of nests with their cryptic plumage (Martin 1993). Thus, the absence of parental defense may contribute to higher predation rates on artificial nests relative to natural nests in this and other studies.

In conclusion, the results of this study suggest that predation rates on artificial nests yield overestimates of nest predation rates on natural nests. Further work on the degree to which artificial nests provide a reliable measure of *relative* nest predation rates among treatments or habitats (e.g., Wilson et al. 1998) would be a valuable contribution to the evaluation of this widely used technique.

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