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COVER CHARACTERISTICS AND SUCCESS OF NATURAL AND ARTIFICIAL DUCK NESTS

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Abstract.—Artificial nests have become an important tool for avian ecologists. Results obtained with artificial nests are sometimes used to predict success of natural nests or to characterize spatio-temporal changes in success of natural nests, but only rarely is success of artificial and natural nests actually compared. We found no correlation between success of natural and artificial duck nests in the same year, nor did artificial nests accurately portray between-year changes in survival of natural nests. Furthermore, despite extensive experience working with natural duck nests, we were unable to place artificial nests in locations that matched vegetative characteristics of natural nest sites. Natural nests had denser, taller vegetation than artificial ones. Overhead concealment was greater at successful natural nests, but no difference was found with artificial nests. Researchers should be cautious when using artificial nests to predict natural nest success and should be aware of possible differences in vegetative features that may affect nest survival.

CARACTERÍSTICAS DE LA COVERTURA Y ÉXITO DE NIDOS NATURALES Y ARTIFICIALES DE PATOS

Sinopsis.—Los nidos artificiales se han convertido en una importante herramienta de trabajo para los ecólogos. Los resultados obtenidos en el estudio de nidos artificiales en ocasiones se utilizan para predecir el éxito de nidos naturales o para caracterizar los cambios espacio-temporales en el éxito de nidos naturales. No obstante, raras veces el éxito de nidos artificiales es comparado al de nidos naturales. No encontramos correlación entre el éxito de nidos naturales y artificiales de patos durante un mismo año. Tampoco los nidos artificiales resultan ser una imagen de exactitud, entre años, de la sobrevivencia de los nidos naturales. Más aún, no empece a la gran experiencia de trabajar con nidos naturales, no fuimos capaces de colocar un nido artificial en una localidad que pareara con las características de la vegetación de nidos naturales. Los nidos naturales tienen vegetación más densa, y de mayor altura que los artificiales. Los nidos con mayor cantidad de vegetación, cubriendo la parte superior de estos, resultaron ser los nidos naturales más exitosos; no se encontró diferencia entre nidos artificiales. Los investigadores deben ser más cuidadosos cuando usen los resultados de nidos artificiales para predecir el éxito de nidos naturales. Además, deben estar concientes que diferencias en las peculiaridades de la vegetación pudieran afectar la supervivencia de los nidos.

Artificial nests have become an important tool for avian ecologists because difficulties frequently arise when studying natural nests (e.g., small sample sizes, increased nest abandonment). For instance, artificial nests have been employed to investigate predation rates in relation to nest density (Niemuth and Boyce 1995, Sugden and Beyersbergen 1986), nest concealment (Esler and Grand 1993, Jones and Hungerford 1972, O'Reilly and Hannon 1989, Sugden and Beyersbergen 1986), and habitat (Seitz and Zegers 1993, Yahner et al. 1993) and to identify nest predators (Picman 1987, Picman and Schriml 1994). In many cases, it is tacitly assumed that results obtained from artificial nests are representative of natural nests, but only rarely has this assumption been evaluated.

Many studies have investigated the relationship between concealment and predation risk, some employing only artificial nests (Esler and Grand 1993, Jones and Hungerford 1972, O'Reilly and Hannon 1989, Sugden and Beyersbergen 1986) and others using both natural and artificial nests (Dwernychuk and Boag 1972, Storass 1988). There are conflicting reports about the importance of nest site vegetation cover in protecting eggs and parent birds from predators. One hypothesis states that poorly concealed nests are more easily found by predators, and several studies have reported that predation is inversely related to vegetative concealment (Dwernychuk and Boag 1972, Hill 1984, Jones and Hungerford 1972, Klimstra and Roseberry 1975, Martin 1988, Mankin and Warner 1992, Riley et al. 1992, Sugden and Beyersbergen 1986). Conversely, other studies have found no relationship between concealment and predation (Bowman and Harris 1980, Esler and Grand 1993, Gottfried and Thompson 1978, Haensly et al. 1987, O'Reilly and Hannon 1989, Schieck and Hannon 1993).

If results of studies that used artificial nests are to be used to infer how various factors affect the fate of natural nests, the assumption that they correlate well should be evaluated. We compared natural and artificial nests in terms of: (1) estimated nesting success on the same plots, (2) between-year changes in nesting success on the same study area, (3) vegetation features, and (4) concealment of successful and depredated nests.

STUDY AREA AND METHODS

Work was conducted from April–July, 1991 and 1992, in Saskatchewan parkland habitat about 10 km south of Prince Albert (53°10'N, 105°40'W). This gently rolling area contains many wetlands and small groves of aspen (*Populus tremuloides*). The landscape is dominated by agriculture, especially cereal grain, oil seed and alfalfa seed production, and the pasturing of cattle. In 1991, four 2.56 km^2 study sites were chosen; in 1992, the study area again included four sites (2.56 km^2) of which two were used in 1991. All study sites were selected based on homogeneity of habitat, with geometric centers of sites separated by at least 4 km.

Data collection.—All study sites were searched systematically for duck nests at least twice from early May to mid-July. Searches were conducted in all available habitat, except cropland and densely vegetated habitat (thick shrubs and trees). Most habitat types were searched using a chain dragged between two all-terrain vehicles (Higgins et al. 1977). Habitats that could not be searched with ATVs were searched on foot by persons pulling a rope. When a nest (a scrape or nest bowl containing at least one egg) was found, we recorded species, number of eggs, and stage of incubation (Weller 1956). Nests were marked with bamboo canes placed at varying directions 2 m from the nest. Nests were revisited every 7–10 d to determine fate. Nests were considered successful if at least one egg hatched.

Artificial nests were constructed to resemble duck nests and consisted of eight chicken eggs dyed (with tea) to mimic duck eggs. One egg was filled with paraffin to aid in predator identification. Nest bowls were made by removing ground vegetation and creating a shallow depression approximately 15 cm in diameter. Bowls were lined with dried grasses, Mallard (*Anas platyrhynchos*) down and body feathers, and were concealed by vegetation.

We placed artificial nests at randomly selected locations (excluding cropland) in typical duck nesting habitat. We marked nests with bamboo canes (as above) and revisited every 7–10 d to determine fate. A nest was considered destroyed if one or more eggs were missing or eaten, indicating that a predator had discovered the nest. Two trials (each lasting 24 d) were conducted; one from mid-May to mid-June, and the other from mid-June to mid-July. During each trial, 15 nests were placed in each study site. Including natural nests, there were rarely more than 30 (artificial and natural duck) nests active on a site, a density ($\leq$ 0.5 nests/ha) probably well below the level (1 nest/ha) needed to trigger density-dependent nest predation (Sugden and Beyersbergen 1986).

Measurements were taken at all natural and artificial nests when fate was determined (i.e., successful or destroyed). KLG took all vegetation measurements to remove variability between observers. Nests abandoned due to human disturbance were omitted from all analyses. Horizontal density was quantified using a 1-m vegetation profile board marked at 10-cm intervals (modified from Nudds 1977). Coverage of each 10-cm interval was estimated with the board placed immediately behind the nest and the observer located 1 m in front of the board. At each nest, four height measurements were taken with a meter stick. Measurements were taken directly adjacent to the nest in the four cardinal directions.

In 1992, overhead concealment was quantified using a circular disk (14-cm diameter) with five evenly spaced, 6.25-cm^2 black squares painted on it (similar to Clark et al. 1991). The disk was placed in the nest bowl and the percentage of each square occluded by vegetation was estimated when viewed from 1 m directly above the nest. The score from all five squares was summed to yield an index of overhead concealment.

Data analysis.—Scores for each 10-cm layer were summed over all layers to obtain a lateral density score. The four height measurements were averaged to provide an estimate of vegetation height. Differences between successful and depredated nests in lateral density, overhead concealment, and height were then evaluated using logistic regression (PROC LOGISTIC), controlling changes in vegetation features associated with date and

TABLE 1. Mayfield nest success for upland-nesting ducks and success (% of nests that "survived" 24-d exposure period)[a] of artificial nests near Prince Albert, Saskatchewan, 1991 and 1992. Shown are estimates of success (%) and sample size (n).

Year and site	Waterfowl nest success	Artificial nest success
1991		
22	4.0 (13)	68 (28)
28	3.5 (10)	65 (26)
8	1.6 (15)	53 (30)
11	18.1 (32)	67 (27)
Overall	7.7 (70)	63 (111)
1992		
22	0.3 (10)	18 (28)
2	27.1 (27)	23 (30)
11	23.6 (11)	37 (30)
19	2.9 (36)	24 (29)
Overall	8.9 (84)	26 (117)

[a] A total of 30 randomly-located simulated nests was deployed. However, numbers do not total 30 when nests were destroyed by farming operations.

year. The relationship between vegetation concealment and fate was analyzed across study sites to determine if there were any site effects (ANCOVA; PROC GLM). Finally, characteristics of artificial and natural nest vegetation were compared using ANCOVA (PROC GLM), adjusting for potential effects of date and year.

Success of artificial nests was the number that survived divided by the number deployed (less any that were destroyed by farming operations). Success of waterfowl nests was estimated with Mayfield's (1975) method. Nests were excluded from analyses based on criteria of Klett et al. (1986). To control for annual variation in nest success, estimates were converted to z-scores. The z-scores were used in a Spearman's rank correlation to test for association between artificial and natural nest success.

Statistical tests follow Zar (1984) or Siegel and Castellan (1988). Unless otherwise stated, tests were two-tailed with significance set at $P < 0.05$. Analyses were performed on the Statistical Analysis System (SAS Institute 1990).

RESULTS

Correlation between nest types.—A simple comparison between natural and artificial nests (Table 1) revealed that, in seven of eight comparisons, success of artificial nests exceeded natural nests. A nonsignificant but weak positive correlation ($r_s = 0.59$, $P = 0.12$, $n = 8$) was found between success of natural and artificial nests.

Nest success between years.—On site 22, natural and artificial nest success declined from 1991 to 1992, but changes were not of the same magnitude (Table 1). Natural nest success on site 11 increased from 1991 to 1992, but artificial success decreased by almost half. When data for all sites were combined and compared between years, natural nest success changed very little between 1991 and 1992, but artificial nest success declined by more than half (Table 1).

Comparison of vegetation features at artificial and natural nests.—Vegetative features at natural and artificial nests were compared, while controlling possible effects of date and year. Overhead concealment did not differ between artificial and natural nests ($F = 1.61$, $P = 0.21$). However, natural nests had denser horizontal vegetation ($F = 16.01$, $P = 0.0001$) and taller vegetation ($F = 11.28$, $P = 0.0008$) than artificial nests.

Relationship between concealment and fate.—With natural ($\chi^2 = 0.93$, $P = 0.34$) and artificial ($\chi^2 = 0.80$, $P = 0.26$) nests, lateral density scores were unrelated to nest fate (Table 2). Overhead concealment was lower at depredated natural nests ($\chi^2 = 4.91$, $P = 0.027$), but did not differ ($\chi^2 = 0.18$, $P = 0.67$) among artificial nests of different fate categories. Mean vegetation height at successful and depredated natural ($\chi^2 = 0.006$, $P = 0.94$) and artificial ($\chi^2 = 1.57$, $P = 0.21$) nests did not differ.

When all three vegetation measures were analyzed together (1992 data only), there was no difference in concealment between successful and unsuccessful artificial nests ($\chi^2 = 2.66$, $P = 0.61$, 4 df), but vegetative features did affect fate of natural nests ($\chi^2 = 64.4$, $P = 0.0001$, 4 df). There was no interaction between site and fate ($F = 0.97$, $P = 0.45$) indicating that the relationship between concealment and fate did not vary across sites.

DISCUSSION

Reliability of artificial nest success estimates.—Artificial nests are often used to investigate factors affecting survival of natural nests. However, we demonstrated that artificial and natural nest success were not significantly correlated (see also Dwernychuk and Boag 1972, O'Reilly and Hannon 1989, Willebrand and Marcstrom 1988). In addition to a lack of correlation in nest success, patterns in nest survival rates also differed, limiting the usefulness of artificial nests as an index of predation. Therefore, we suggest caution when artificial nests are used to predict success of natural nests, or used as an index of survival for natural nests.

Vegetative differences at natural and artificial nests.—Although several studies have used artificial nests to investigate relationships between concealment and predation (Esler and Grand 1993, Jones and Hungerford 1972, O'Reilly and Hannon 1989, Sugden and Beyersbergen 1986) few compared concealment at artificial and natural nests. Although general nest locations for artificial nests were randomly located in duck nesting habitat, we placed nests only in locations that we felt were typical of natural nest sites. Sites chosen for artificial nests appeared to be similar to natural nest locations, but lateral density and vegetation height were both lower for artificial nests. This emphasizes the need to compare vegetation characteristics at both artificial and natural nest sites if conclusions are to be drawn from artificial nests, particularly when vegetation features affect nest survival.

TABLE 2. Lateral density score, overhead concealment score, and vegetation height (cm) at natural and artificial nests for successful and depredated clutches, Prince Albert, Saskatchewan, 1991 and 1992. Shown are least square means (adjusted for date), standard error, and number of nests in parentheses.

	Artificial		Natural	
Vegetation measurement	Depredated	Successful	Depredated	Successful
Lateral density (1991 & 1992)	23.1 ± 1.3 (114)	24.6 ± 0.9 (220)	26.7 ± 1.5 (111)	30.0 ± 2.2 (59)
Overhead concealment (1992 only)	243.2 ± 9.3 (67)	247.9 ± 6.5 (138)	234.4 ± 17.1 (80)	309.2 ± 24.0 (46)
Height (1991 & 1992)	47.2 ± 2.8 (109)	49.9 ± 1.7 (203)	54.8 ± 1.7 (112)	53.9 ± 2.5 (59)

Of the three vegetation measurements recorded, only overhead concealment was related to nest success. At natural nests, overhead concealment was greater for nests that survived, but there was no relationship with artificial nests. Although several studies have reported an inverse relationship between vegetative concealment and fate (Dwernychuk and Boag 1972, Hill 1984, Jones and Hungerford 1972, Klimstra and Roseberry 1975, Mankin and Warner 1992, Martin 1988, Riley et al. 1992, Sugden and Beyersbergen 1986), concealment generally is not a consistent factor affecting nest fate (Bowman and Harris 1980, Esler and Grand 1993, Gottfried and Thompson 1978, Haensly et al. 1987, O'Reilly and Hannon 1989, Schieck and Hannon 1993). Overhead concealment may camouflage incubating female ducks and reduce their vulnerability to avian predators (Schieck and Hannon 1993). Red-tailed Hawks (*Buteo jamaicensis*), American Crows, Swainson's Hawks (*Buteo swainsoni*) and Great Horned Owls (*Bubo virginianus*) were common on most study sites (Guyn 1994). Because overhead concealment was greater at successful natural nests, perhaps avian predators were locally important.

When all concealment measurements were considered simultaneously, vegetation features were not related to nest success for artificial nests, but concealment was important for natural nest survival. Several authors (Duebbert and Kantrud 1974, Duebbert and Lokemoen 1976, Hines and Mitchell 1983, Livezey 1981, Schrank 1972) have suggested that dense vegetation acts as a visual and scent barrier between nests and predators. However, others have postulated that the main effect of dense cover is to reduce the foraging efficiency of predators (Crabtree et al. 1989). Clark and Nudds (1991) suggested that nest concealment may be most important when the primary predators are birds. Mammalian predators may depend primarily on olfactory cues and therefore may prey upon nests irrespective of concealment. The main predators in this study, identified at artificial nests (Guyn 1994), were mammals. Dwernychuk and Boag (1972) found that tall cover protected artificial nests, but not real nests, from predation. However, unlike this study, Dwernychuk and Boag (1972) did not place duck down or feathers in the nest. Because their nests presumably did not have any duck scent, mammals likely detected the nests visually.

Conclusion.—We found that artificial nest success was not correlated with natural nest success, nor did it provide an accurate index of natural nest success patterns. Despite our efforts to place artificial nests in 'typical' duck nest locations, natural nests had greater lateral cover and taller vegetation than artificial nests. Concealment was an important factor in determining natural nest fate but was not significant for artificial nests. Therefore, extrapolation of results with artificial nests to natural situations should be made cautiously, especially when vegetative features of nest sites contribute to survival of eggs, young and (or) parents.

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