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Effects of Microsite Selection on Predation of Artificial Ground Nests

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ABSTRACT.—We studied the effects of microsite selection on depredation of artificial ground nests in central Pennsylvania from May–July 1996. Our objectives were to compare depredation of artificial ground nests in relation to the type of structure (tree vs log) adjacent to a nest and the direction (north vs south) of a nest from the structure. Sixty nests were placed in each of five trials with 20 nests each placed in contiguous forest, forested patch, and forested corridor habitats. Eighty-eight (29%) of the 300 artificial nests were disturbed during five trials. The number of disturbed nests did not significantly vary ($P > 0.05$) with time period (trial). Nest fate differed significantly among the three habitats ($P = 0.001$), with 20%, 43%, and 25% of the nests disturbed in the contiguous forest, forested patch, and forested corridor habitats, respectively. These rates of nest predation corresponded to those reported in previous studies of artificial ground nests at the same study site in central Pennsylvania. Nest fate was not associated with the type of structure at the nest site ($P > 0.05$) or with the direction of the nest from the structure ($P > 0.05$). We conclude that neither the type of ground-level structure near which artificial ground nests are placed nor the direction of nests from these structures influences nest fate. *Received 2 Dec. 1997, accepted 17 April 1998.*

Artificial nest studies have shown experimentally that avian nesting success declines with reduced forest size or with greater forest fragmentation (e.g., Wilcove 1985, Yahner and Scott 1988, Yahner et al. 1993, Yahner and Mahan 1996a). Previous studies also have shown that depredation of artificial nests may vary with time of placement during the season, degree of concealment provided by vegetation surrounding the nest site, and color of eggs used in artificial nests (Sugden and Beyersbergen 1986, Yahner and Wright 1985, Yahner and Mahan 1996b). Yahner and Voytko (1989) observed that depredation of artificial aboveground nests placed at random sites did not differ ($P > 0.05$) from nests placed at sites used by birds the previous breeding season. Yahner and Mahan (1996b) recommended the use of brown chicken eggs to simulate nests of Ruffed Grouse (*Bonasa umbellus*) and Wild Turkey (*Meleagris gallopavo*) in artificial nest studies. Investigators of these types of ground nests typically place a small clutch of brown chicken eggs in a slight depression adjacent to a large tree or log (e.g., Yahner and Wright 1985, Yahner et al. 1993). However, the effects of microsite selection for placement of artificial ground nests have not been examined to our knowledge. Our objectives were to compare predation of artificial ground nests in relation to the type of structure (tree vs log) adjacent to a nest and the direction (north vs south) of a nest from the structure.

STUDY AREA AND METHODS

We conducted our study at the 1166-ha Barrens Grouse Habitat Management Area (HMA), State Game Lands 176, Centre County, Pennsylvania, which has been the location of several previous studies on artificial ground nests (e.g., Yahner and Wright 1985; Yahner et al. 1993; Yahner and Mahan 1996a, b). The Pennsylvania Game Commission has created habitat for Ruffed Grouse at the study area since 1976 using an even-aged system of forest clearcutting (see details in Yahner 1993, Yahner et al. 1993). The Barrens Grouse HMA contains a sector reference and a treated sector of similar size. The reference sector is uncut and is termed the contiguous forest habitat. The treated sector is divided into forested patch and forested corridor habitats (Yahner 1993, 1997).

Forest in the reference sector, in uncut plots of both forested patch and forested corridor habitats, and adjacent to the Barrens Grouse HMA, has not been cut for approximately 75–80 years. Principal overstory trees (woody stem > 7.5 cm dbh and > 1.5 m tall) on each sector were white oak (*Quercus alba*), northern red oak (*Q. rubra*), chestnut oak (*Q. prinus*), scarlet oak (*Q. coccinea*), red maple (*Acer rubrum*), quaking aspen (*Populus tremuloides*), bigtooth aspen (*P. grandidentata*), and pitch pine (*Pinus rigida*; Yahner 1993, 1997). Major understory trees (woody stem = 2.5–7.5 cm dbh and > 1.5 m tall) and tall shrubs (woody stems < 2.5 cm dbh and > 1.5 m tall) included oak, red maple, aspen, and black cherry (*Prunus serotina*).

The treated sector contained 136 contiguous 4-ha blocks; each block consisted of four 1- ha (100 × 100 m) plots arranged in a clockwise pattern (plots A–D; Yahner 1993, 1997). In each block of the forested patch habitat, only plot D was uncut, whereas plot A was clearcut in winter 1976–1977, plot B in winter 1980–1981, and plot C in winters 1985–1986 and

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TABLE 1. Fate of 300 artificial ground nests in relation to time period, habitat, type of structure adjacent to the nest, and direction of the nest from the structure at the Barrens Grouse Habitat Management Area, Centre County, Pennsylvania, 1996.

		Nest fate			
		Undisturbed		Disturbed	
Variable	Level	*n*	%	*n*	%
Time period	Trial 1	40	67	20	33
	Trial 2	46	77	14	23
	Trial 3	47	78	13	22
	Trial 4	45	75	15	25
	Trial 5	34	57	26	43
Habitat	Contiguous forest	80	80	20	20
	Forested patch	75	75	25	25
	Forested corridor	57	57	43	43
Structure type	Tree	107	70	46	30
	Log	105	71	42	29
Nest direction	North	108	68	51	32
	South	104	74	37	26

1986–1987. In the forested corridor habitat, both plots C and D were uncut, but plot A was clearcut in winter 1976–1977, and plot B was cut in winters 1985–1986 and 1986–1987. Thus, the forested patch habitat gave a checkerboard pattern of cut plots (A–C) and uncut plots (D), whereas the forested corridor habitat consisted of alternating strips of cut plots (A and B) and uncut plots (C and D).

Ruffed Grouse and Wild Turkey were common gallinaceous birds nesting at ground level at the Barrens Grouse HMA; potential predators on nests of these species included American Crow (*Corvus brachyrhnchos*), Blue Jay (*Cyanocitta cristata*), Virginia opossum (*Didelphis virginianus*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), black bear (*Ursus americanus*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*) and snakes (Therres 1982, Yahner and Mahan 1996b).

We placed artificial ground nests during five time periods (trials) from late May through late July 1996 (Table 1). A nest contained three fresh, brown chicken eggs and was put in a slight depression immediately adjacent (nearest egg approximately 3 cm away) to the nearest ground-level structure (tree or log ≥ 15 cm diam) and either north or south of the structure (after Yahner and Wright 1985, Yahner et al. 1993). Brown chicken eggs were used to simulate the contents of actual nests of grouse or turkey (Yahner and Mahan 1996b).

Each trial was six days, and eight days elapsed between trials (Yahner and Scott 1988, Yahner et al. 1993). During a trial, 20 random sites for nest placement were selected for nest placement in the contiguous-forest habitat; 20 uncut plots (plot D) were also randomly selected for nest placement in both forested patch and forested corridor habitats. This experimental design gave a total of 300 nests (Klett and Johnson 1982) which were randomly placed for each trial and habitat at one of four types of sites: north of a tree, north of a log, south of a tree, or south of a log. Nest sites in the forested corridor habitat were at least 50 m from a disturbance (e.g., logging road); nest sites in the other two habitats were placed approximately 50 m from an edge in the center of plot D. Rubber gloves and boots were worn to reduce human scent when placing nests (Nol and Brooks 1982).

We determined the fate (undisturbed or disturbed) of nests six days after placement between 07:00 and 13:00 (EST). A nest was disturbed if at least one egg was broken or missing. Appearance and mode of disturbance of eggs were used occasionally to identify the type of predator, e.g., peck holes in eggs often were characteristic of avian predators (Rearden 1951, Yahner and Wright 1985). Eggs and egg fragments were removed at the end of each trial.

We examined the dependency of nest fate (undisturbed vs disturbed), time period (trials 1–5), habitat (contiguous forest, forested patch, and forested corridor), type of structure at the nest site (tree vs log), and direction of eggs from structure (north vs south), using a five-way test-of-independence (BMDP4F, Dixon 1990). Interactions of nest fate with the other variables were tested with likelihood ratios (G^2) based on log-linear models, which are suitable when analyzing attribute data in multi-way contingency tables (Dixon 1990, Sokal and Rohlf 1995). We used *a posteriori* G-tests for goodness-of-fit about the cells (levels) of interest if nest fate was significantly dependent on a given variable (Sokal and Rohlf 1995). All statistical analyses were performed using BMDP4F software on an IBM/CMS computer.

RESULTS

Eighty-eight (29%) of the 300 artificial ground nests were disturbed during the five trials (Table 1). Of these disturbed nests, only nine (10%) were attributed to avian predators;

the identity of predators on the remaining disturbed nests was unknown. The number of disturbed nests did not vary significantly ($P > 0.05$) with time period, ranging from 22–43% of nests disturbed per trial. More nests were disturbed in the forested patch habitat (43%) than in either the contiguous forest (20%) or forested corridor habitats (25%). The number of disturbed nests in the forested patch habitat was significantly higher than expected compared to either the forested corridor or contiguous forest habitats (all G values ≥ 4.8, df = 1, $P < 0.05$); however, the number of disturbed nests was similar ($P > 0.05$) between forested corridor and contiguous forest habitats.

Nest fate was not associated with the type of structure at the nest site ($P > 0.05$), the direction of the nest from the structure ($P > 0.05$), or with interactions of two other variables (i.e., time period and habitat) considered simultaneously (all $P > 0.05$). Forty-six (30%) of the nests adjacent to trees were disturbed compared to 42 (29%) nests near logs. Fifty-one (32%) of the nests placed north of a structure were disturbed compared to 37 (26%) of the nests located south of a structure.

DISCUSSION

Our finding that 29% of the artificial ground nests were disturbed during the study corresponds to rates of disturbance noted in previous studies of artificial ground nests using brown chicken eggs at the Barrens Grouse HMA (22–42%: Yahner et al. 1993; Yahner and Mahan 1996a, 1996b) or to predation rates on ground nests of Spruce Grouse (*Canachites canadensis*; 17–70%: Redmond et al. 1982). Moreover, as in a previous study subsequent to clearcutting in winters 1985–1986 and 1986–1987 (third cutting cycle) at the study area, avian predation on artificial ground nests has continued to be low (9%) compared to the pre-1985 era when avian predation tended to be higher (36%; see discussion by Yahner et al. 1993). Also, as in recent studies at the Barrens Grouse HMA, numbers of disturbed nests did not significantly differ among trials (Yahner et al. 1993, Yahner and Mahan 1996a).

Our finding that nests in the forested patch habitat were more likely to be disturbed than nests in either the contiguous forest or forested corridor habitats has been documented in previous studies of artificial ground nests (Yahner and Mahan 1996a), artificial aboveground nests (Yahner and Mahan, unpubl. data), and actual nests of Wood Thrush (*Hylocichla mustelina*; Yahner and Ross 1995) at the Barrens Grouse HMA. Yahner and Mahan (1996a) concluded that higher rates of nest predation in small uncut forest patches than elsewhere was perhaps the result of both greater amounts of forest edge and greater foraging success by predators in uncut plots in the forested patch habitat. Edge species, e.g., raccoons and American Crows, probably also foraged disproportionately more in the small forested patches than in the contiguous forest or forested corridors (Yahner and Mahan 1997).

The major result of our study, which has implications on the experimental design of studies using artificial ground nests, is that depredation did not vary with respect to microsite features. We expected *a priori* that nests proximal to logs or those placed south of a ground-level structure would be more susceptible to visually foraging predators, such as corvids that forage during the day, than those placed near trees or in a northerly direction (e.g., Yahner and Wright 1985). A nest next to logs, for instance, presumably would be detected more readily from above the nest than a nest adjacent to an overstory tree. Furthermore, with the sun moving from east-to-west in the southerly sky above the forest canopy, a nest placed in a northerly direction from a structure would be better shaded and, hence, possibly better concealed from visually oriented predators than a southerly nest.

In conclusion, we believe that the type of ground-level structure near which artificial ground nests are placed or direction of nests from these structures will not have a major influence on nest fate provided that nests are within a reasonable distance (nearest egg approximately 3 cm away) from a relatively large ground-level structure (≥ 15 cm diam).

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