

THE EFFECT OF DISTURBANCE ON MOURNING DOVE NESTING SUCCESS

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ABSTRACT.—Disturbed and undisturbed Mourning Dove (*Zenaida macroura*) nests were compared for differences in daily survival probabilities and discrepancies in the relationships between nest-site features and nesting outcome. At 3-day intervals, attending adults were flushed from disturbed nests ($n = 51$), whereas undisturbed nests ($n = 50$) were checked from a distance so that adults did not flush. Disturbed nests had significantly ($P < 0.1$) lower daily survival probabilities; this trend was evident during both the incubation and nestling stages, but was significant only during the former. For disturbed nests, two nest-site features (nest-bowl depth and nest support) were related to success ($P < 0.1$). In contrast, success of undisturbed nests was related to four variables (substrate height above nest level, relative light intensity above the nest, nest concealment, and nest width). These results indicate that standard nest-checking procedures influence nesting success and confound interpretation of relationships between nest-site features and nesting outcome. Received 10 December 1984, accepted 30 April 1985.

MANY studies of the relationship between nesting success and nest-site features have resulted in conflicting findings. For example, some authors (Meanley and Webb 1963, Holcomb and Twist 1968) have reported that nesting success for Red-winged Blackbirds (*Agelaius phoeniceus*) is positively related to nest height, whereas others have found a negative relationship (Goddard and Board 1967, Ortego and Hamilton 1978) or none at all (Francis 1971, Lenington 1980). Similar contradictory results have been reported for Field Sparrows (*Spizella pusilla*; Best 1978, Evans 1978) and Mourning Doves (*Zenaida macroura*; Nice 1923, Schroeder 1970). Although researchers have studied several bird species in diverse settings, most have found no relationship between nest concealment and nesting success (Roseberry and Klimstra 1970, Caccamise 1977, Best 1978, Gottfried and Thompson 1978, Best and Stauffer 1980, Lenington 1980; but see Nolan 1978, Wray and Whitmore 1979, Murphy 1983). Because predation often is the major cause of nest failure in avian communities (Nolan 1963, Best and Stauffer 1980), one would expect concealment to have a direct causal effect on nesting outcome.

The reason nest-site features often seem unrelated to nesting success may be that researcher disturbance confounds the normal relationship between nest microhabitat and nesting outcome. If nest checks provide additional cues or enhance existing cues that predators use to

find nests, the value of concealment under natural conditions may be obscured. In the summer of 1983, we tested this hypothesis with Mourning Dove nests. Any negative effect that nest checks have on nesting success should be particularly evident for this species because the adults have noisy wingbeats [sometimes accompanied by a distraction display (Nice 1923)] when flushed from the nest, and the eggs are noncryptic (white). The former could direct a predator's attention to the nest vicinity, and the latter probably makes the nest more conspicuous. Under natural (undisturbed) conditions, Mourning Doves attend the nest continuously (Harris et al. 1963).

Bart (1977) examined nest records for Mourning Doves and found evidence that nesting success is reduced by researcher disturbance, but his results also can be explained by reporting bias (Bart and Robson 1982). Nichols et al. (1984) reported that daily vs. weekly visits to Mourning Dove nests did not differentially affect nesting success, but they did not study undisturbed nests. Our objectives were to compare nesting success between disturbed and undisturbed nests and to determine if disturbance obscures relationships between nest-site features and nesting outcome.

STUDY AREA AND METHODS

The study was conducted from May through August 1983 at Big Creek State Park, Polk County, Iowa. A 110-ha section of the park contains several kilo-

meters of windbreaks; each windbreak consists of a multiflora rose (*Rosa multiflora*) hedge flanked on one or both sides by double rows of jack pine (*Pinus banksiana*) or white pine (*P. strobus*). Most trees are less than 6 m tall, and land use between windbreaks is rotated between corn, alfalfa, oats, or nonuse. The windbreaks are spaced at intervals of about 60 m. Eastern red cedar (*Juniperus virginiana*) is a common invader in perennially uncultivated areas.

We located nests by walking between pine rows and flushing nesting parents. All rows were searched weekly, and uncultivated field edges were searched irregularly. When nests were discovered, we determined the age of eggs or nestlings by using the descriptions in Hanson and Kossack (1963). We considered a nesting cycle initiated on the day the first egg was laid. Nests were randomly assigned to either disturbed or undisturbed treatments. For the disturbed treatment, we approached nests directly, flushed the attending adult, and examined the nest contents. We checked undisturbed nests from a distance (usually >10 m) so that the attending adult did not flush. Mourning Doves continuously attend the nest until the young are near fledging age (Nice 1922), so presence of an adult was taken as evidence that the nest was still active. In the latter half of the nestling stage, we often could see the nestlings directly.

Nests in both treatments were checked every 3 days; when a nest failed, we assumed that it had survived for 1.5 days after the previous visit. Because all nests were disturbed when discovered initially, we eliminated from analyses all data for the interval between nest discovery and the subsequent visit. Nests that failed during this period were not used in analyses.

After a nest failed or the young fledged, we recorded the species and height of the nest substrate, nest height above the ground, nest width, depth of the nest bowl, horizontal distance from the nest to the periphery of the substrate canopy, and, as an index of nest support, the total (sum) diameter of branches supporting the nest. Nest-bowl depth was measured by placing a straightedge across the nest and recording the perpendicular distance from it to the center of the nest. The substrate height above nest level was calculated from nest and substrate height measurements. Visual concealment at nest level was rated as poor, fair, good, or excellent (yielding values of 1–4, respectively). These estimates were made about 5 m from the nest in each of the four cardinal directions; the mean was used as an overall index of concealment around the nest. We estimated concealment above the nest by recording light intensity immediately above the nest and expressing it as a percentage of ambient light intensity.

We considered a nesting attempt successful if the young survived to 10 days of age (Coon et al. 1981, Nichols et al. 1984). Nestlings usually remain in the nest until age 13–14 days but will fledge at 10 days if disturbed. Failures were attributed to predators un-

less eggs or nestlings were found on the ground beneath the nest. When the nest structure was damaged, we considered mammals responsible. If the nest was intact, the failure was attributed to avian predators. Snakes and chipmunks (*Tamias striatus*) were rare in the study area, and we discounted the importance of small nocturnal mammals (mice, shrews, etc.) because at least one adult dove was always present at the nest overnight.

To compare differences in nesting success, we calculated the daily nest survival probability (Mayfield 1975) and applied the statistical test developed by Hensler and Nichols (1981). For these we used one-tailed tests at a rejection level of $P < 0.1$. This relaxed rejection level increases the power of the test (Hensler and Nichols 1981) and has been the convention of previous researchers (Coon et al. 1981, Nichols et al. 1984). We used *t*-tests to compare nest-site variables between successful and unsuccessful nests within each treatment; a $P < 0.05$ rejection level was used for these analyses.

RESULTS

Of the 150 nests found, 32 failed and 13 were abandoned between initial discovery and the first revisit. We eliminated 4 additional nests from the undisturbed category because they could not be checked without flushing the parent. The remaining 101 nests were used for analyses. Median clutch age at discovery for these nests was 5 days.

Forty-three percent of all (101) nests successfully fledged at least one young; the daily survival probability for all nests combined was 0.946, yielding a nesting-success estimate of 21% for a 28-day nesting cycle. We attributed 79% of the nest failures to avian predation. Doves nested primarily in jack pine (61% of nests), multiflora rose (13%), and eastern red cedar (8%). The remaining nests were placed in elm (*Ulmus* spp.), mulberry (*Morus* spp.), and honey locust (*Gleditsia triacanthos*) trees and in various shrubs. Daily nest survival probabilities did not differ ($P > 0.1$) among the three primary substrates (treatments pooled).

Effects of disturbance on nesting success.—Thirty-seven percent of disturbed nests and 50% of undisturbed nests were successful. Daily nest survival probabilities were significantly lower for disturbed nests ($P < 0.1$); this trend was present during both the egg and nestling stages, but was significant only during the former (Table 1). By Mayfield estimates, disturbed nests were about 50% as successful as undisturbed nests.

TABLE 1. Nesting success estimates for disturbed and undisturbed Mourning Dove nests.

	Nests	No. of failures	Daily nest survival probability	Estimated success ^a
Incubation				
Disturbed	43	15	0.943 ± 0.014 ^{*b}	44%
Undisturbed	42	9	0.966 ± 0.011	62%
Nestling period				
Disturbed	36	17	0.926 ± 0.017	34%
Undisturbed	41	16	0.947 ± 0.013	47%
Combined				
Disturbed	51	32	0.935 ± 0.011 [*]	15%
Undisturbed	50	25	0.956 ± 0.01	29%

^a Based on incubation and nestling periods of 14 days each.

^b * = significant difference between disturbed and undisturbed nests at $P < 0.1$.

Daily nest survival probabilities were lower during the nestling stage than the egg stage (Table 1). The data are biased, however, because we did not include nests that failed between initial discovery and the first revisit; most of these failures occurred during incubation. Other researchers have shown that Mourning Dove clutches are more likely to survive the nestling period than the incubation period (Harris et al. 1963, Caldwell 1964, Schroeder 1970, Best and Stauffer 1980).

Nest reuse.—About 13% of the nests had been used in previous nesting attempts; 5 were reused dove nests and 8 were nests of Common Grackles (*Quiscalus quiscula*), American Robins (*Turdus migratorius*), or Red-winged Blackbirds. Nest reuse did not increase nesting success (see also Woolfenden and Rohwer 1969); the daily survival probability was 0.963 for reused nests and 0.956 for new nests ($P = 0.68$, treatments pooled). Nest reuse probably is a time-conserving adaptation for this multibrooded species (Woolfenden and Rohwer 1969).

Reused nests that had been built by other species were significantly ($P < 0.05$) wider (147 ± 9 mm; compare with values in Table 2), deeper (25 ± 3 mm), and had more branch support (74 ± 18 mm) than new nests. In the following analyses, we eliminated data for inter-specific nest reuses from nest width, nest-bowl depth, and nest support because they caused skewed distributions for these variables.

Relationship between nest-site features and nesting success.—Mourning Dove pairs in each treatment used similar nesting sites; no measured variables differed significantly ($P > 0.05$) between treatments, and the standard devia-

tions were comparable. Also, there was no difference ($P = 0.68$) between treatments in the mean age of clutches when nests were discovered. Treatments did differ, however, with respect to which variables were related to nesting success (Table 2). For undisturbed nests, four variables were significantly ($P < 0.05$; substrate height above nest level, nest width) or nearly significantly ($P < 0.1$; relative light intensity, nest concealment) related to success. In contrast, two other variables were significantly (nest-bowl depth) or nearly significantly (nest support) related to outcome of disturbed nests.

DISCUSSION

Effects of disturbance on nesting success.—Willis's (1973) study of Bicolored Antbirds (*Gymnophithys leucaspis bicolor*) is frequently cited as evidence that nest checks do not affect nesting outcome, but researchers should be aware that species seem to differ in their response to visitation. Among solitary-nesting species, nest visitation has been reported to have no effect (e.g. Evans and Wolfe 1967, Roseberry and Klimstra 1970), negative effects (e.g. Bowen et al. 1976, MacInnes and Misra 1972), or even positive effects (Osborne and Osborne 1980). Our results conflict with those of Nichols et al. (1984), who found that daily vs. weekly visits did not differentially affect Mourning Dove nesting success in Maryland. These contrasting results may have arisen because the two study sites had different predator communities. At Big Creek State Park, avian predators caused most nest failures; in contrast, the Maryland study

TABLE 2. Relationship between nest-site features and outcome for disturbed and undisturbed Mourning Dove nests. Values represent means \pm SE.

Nest-site variable	Disturbed nests			Undisturbed nests		
	Successful (n = 19)	Failed (n = 32)	P ^a	Successful (n = 25)	Failed (n = 25)	P ^a
Nest height (m)	1.4 \pm 0.1	1.6 \pm 0.2	0.28	1.6 \pm 0.1	1.5 \pm 0.1	0.47
Substrate height above nest level (m)	1.8 \pm 0.2	2.3 \pm 0.3	0.16	3.0 \pm 0.4	2.0 \pm 0.1	0.04
Distance to substrate perimeter (cm)	85 \pm 5	99 \pm 11	0.28	96 \pm 9	96 \pm 6	0.99
Relative light intensity (%)	20 \pm 3	21 \pm 4	0.86	15 \pm 2	20 \pm 2	0.08
Nest concealment	2.7 \pm 0.1	2.8 \pm 0.2	0.90	2.9 \pm 0.1	2.6 \pm 0.1	0.09
Nest width (mm) ^b	124 \pm 4	118 \pm 3	0.23	128 \pm 4	113 \pm 3	0.005
Nest-bowl depth (mm) ^b	12 \pm 2	17 \pm 1	0.08	16 \pm 1	16 \pm 1	0.89
Nest support (mm) ^b	30 \pm 4	46 \pm 7	0.05	49 \pm 9	37 \pm 5	0.24

^a Probabilities based on Student's *t*-tests.

^b Does not include 8 reused nests of other species.

site had avian, mammalian, and reptilian nest predators. Exposed Mourning Dove clutches probably would be more susceptible in areas where avian predation is dominant, simply because birds rely heavily on sight to locate prey. Mammals, especially nocturnal species, rely to some extent on olfaction, and reptiles seem to be opportunistic (Best 1978).

If researcher-induced nest failures are common in Mourning Dove studies, some reported productivity estimates for this species probably are unrealistically low. In our study, productivity of undisturbed nests, based on Mayfield estimates, was almost twice that for disturbed nests. When estimates are based on the percentage of nests that are successful, however, at least part of this bias may be compensated for because such estimates are likely to be artificially high (Miller and Johnson 1978).

Relationship between nest-site features and nesting success.—Undisturbed, successful nests had significantly more substrate above nest level than those that failed. This variable was not correlated with relative light intensity (Table 3), so it evidently was not an index of visual obstruction by canopy vegetation above the nest. Nests with more substrate above them may have been more successful because they were positioned at a greater distance from predators that moved through the upper canopy or that flew over nest trees. On our study area, the most frequently observed predators were American Crows (*Corvus brachyrhynchos*), which are known to prey on Mourning Dove clutches (Grau 1979). Red-winged Blackbirds and Common Grackles were abundant on the study area and might have been responsible for some nest

failures. The height of substrate above nest level was not related to the success of disturbed nests. We believe this was because predators often saw us flush adults from nests. Once the nest vicinity was located, vegetation above the nest probably would have had little effect on the nest being discovered.

Two variables representing nest visibility—relative light intensity and nest concealment—were significantly correlated to one another (Table 3) and may have been related to the outcome of undisturbed nests, but were not related to the outcome of disturbed nests (Table 2). Undisturbed nests that failed were less concealed and more openly exposed to light than successful nests. These relationships approached statistical significance and probably are biologically meaningful.

In both treatments, successful nests were wider than those that failed; the difference was significant, however, only for undisturbed nests (Table 2). Nest width was not correlated with nest support or any other nest-site feature (Table 3). One explanation of the greater width of successful nests may be related to the duration of nest construction. Some columbids continue to add material to the nest late into the nesting cycle (White 1975). If Mourning Doves do also, or if nests are flattened by the continued presence of adults, successful nests would be wider simply because they were attended longer. We tested this by regressing nest width on the age (as determined by egg or nestling development) of nests that failed. [Because successful nests were larger and always at the upper limit of the nest age distribution (24 days old), including them would have caused an a priori

TABLE 3. Correlation matrix of nest-site variables.*

	NH	SANL	DTSP	RLI	NC	NW	NBD	NS
Nest height	1.00							
Substrate height above nest level	0.44*	1.00						
Distance to substrate perimeter	0.37*	0.47*	1.00					
Relative light intensity	0.21*	0.08	0.04	1.00				
Nest concealment	-0.17	-0.38*	-0.35*	-0.38*	1.00			
Nest width ^b	-0.04	0.05	-0.01	-0.01	0.04	1.00		
Nest-bowl depth ^b	0.20*	0.02	0.11	0.09	0.03	0.18	1.00	
Nest support ^b	0.17	0.33*	0.23*	-0.14	-0.30*	0.01	0.04	1.00

* * = $P < 0.05$.

^b Does not include 8 reused nests of other species.

significant relationship between nest age and width. We reasoned that if nests become wider by continued use or through the addition of twigs, a trend of increasing nest width with nest age should be discernable even for nests that failed.] Although there was a good distribution of ages for nests that failed ($n = 43$, range 5.5–24 days), the regression was nonsignificant ($r^2 < 0.01$, $P = 0.89$), indicating that nests did not increase in width during the nesting cycle. We do not understand why wider nests are more successful, but the trend has occurred again in data from the 1984 field season.

In addition to obscuring the relationship between nest microhabitat and nesting outcome, researcher disturbance may accentuate the importance of nest-site features that otherwise would be unrelated to nesting success. Disturbed, successful nests had less branch support than disturbed nests that failed, and the relationship between nest-bowl depth and nesting success approached significance (Table 2). We cannot explain why these variables would be related to the outcome of disturbed nests. No nests were lost due to severe weather, so variables potentially influencing nest stability probably were of minor importance. Also, reduced nest support probably increased nest visibility from below. Coon et al. (1981) found that nest stability was positively related to Mourning Dove nesting success; thus, their results seem to contradict our findings. Perhaps the relationship between nest support and nesting success in our study is spurious; such a Type I error has a 56% probability of occurring in a series of 16 t -tests.

Researcher disturbance may be the reason that nest-site features important to Mourning Dove nesting success either have differed be-

tween studies or have not been detected previously. Nice (1922) noted that nests built in crotches of trees were twice as successful as those farther out on branches, but Schroeder (1970) found that nests in crotches were subject to rain-soaking. In Minnesota farmstead shelterbelts, Yahner (1983) found no relationship between Mourning Dove nesting success and five nest-site variables similar to those we measured.

We know of only one other study of the effect of disturbance on the importance of nest-site features, and the results were similar to ours. In England, Osborne and Osborne (1980) compared Eurasian Blackbird (*Turdus merula*) nests placed near areas heavily visited by humans with those away from frequent human contact. Nest height and relative light intensity were related to outcome of nests away from disturbance, but no nest-site features affected success of nests near human activity. In contrast to our results, they found that nests near human activity had greater success, probably because predators avoided human contact. Thus, although disturbance evidently has a different effect on nesting success in Eurasian Blackbirds and Mourning Doves, for both species it confounds researchers' attempts to discern relationships between nest-site features and nesting success. Our understanding of the relationships between breeding success, nest-site selection, and predation may be distorted by too-frequent nest visitation.

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