

# EFFECTS OF EDGE CONTRAST ON DEPREDAATION OF ARTIFICIAL AVIAN NESTS

RICHARD H. YAHNER, School of Forest Resources, The Pennsylvania State University, University Park, PA 16802  
THOMAS E. MORRELL, School of Forest Resources, The Pennsylvania State University, University Park, PA 16802  
JON S. RACHAEL,<sup>1</sup> School of Forest Resources, The Pennsylvania State University, University Park, PA 16802

**Abstract:** We examined the effects of edge contrast on depredation of artificial avian nests at interfaces of mature stands and 2- or 12-year-old edges in an aspen (*Populus* spp.) cover type on a ruffed grouse (*Bonasa umbellus*) habitat management study area in central Pennsylvania from May to July 1988. One-hundred forty-nine of 360 nests (41%) were disturbed during the study. Suspected predators were American crow (*Corvus brachyrhynchos*) and blue jay (*Cyanocitta cristata*). Depredation of nests did not vary ( $P > 0.05$ ) with edge contrast (age of edge or vegetative cover) or with time period. However, more arboreal ( $P < 0.05$ ) than ground nests were disturbed; arboreal nests were particularly susceptible to predation by corvids. We conclude that regardless of the degree of edge contrasts, increased amounts of edge created by forest fragmentation will have a greater impact on productivity of birds, particularly to those species that nest above ground. We recommend additional experimental studies of depredation of avian nests along edges in different landscapes to better understand long-term trends in avian productivity.

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Depredation of avian nests may vary with habitat (Chasko and Gates 1982, Andren and Angelstam 1988, Picman 1988), age class of forest stands (Yahner and Wright 1985), extent of forest fragmentation (Wilcove 1985, Yahner and Scott 1988), degree of concealment provided by vegetation (Bowman and Harris 1980, Sugden and Beyersbergen 1986, Yahner and Cypher 1987), distance from edge (Gates and Gysel 1978, Chasko and Gates 1982, Wilcove 1985), and nest height (Joern and Jackson 1983, Yahner and Scott 1988). A few studies suggested that incidences of nest predation may be a function of edge contrast, whereby predation is greater along abrupt edges than along feathered edges (Bider 1968, Ratti and Reese 1988). Thus, Ratti and Reese (1988) recently recommended experimental research emphasizing replication and large sample sizes, to confirm if nest predation varies with edge contrast. Because fragmentation of deciduous forests will continue in the future, thereby creating greater amounts of edge, such studies are timely and provide an understanding of positive and negative edge effects (Ratti and Reese 1988, Yahner 1988, Yahner and Scott 1988).

An even-aged system of forest clearcutting at the Barrens Grouse Habitat Management Study Area (BGMA) in central Pennsylvania resulted

in a mosaic of 1-ha forest plots and, hence, numerous interfaces of clear- and uncut stands. Edge contrast at the BGMA was presumed to be more abrupt along interfaces of younger than along older clearcut stands because of differences in time available for natural plant succession to occur (Ranney et al. 1981, Yahner and Grimm 1984). Our objective was to determine if depredation of artificial ground and arboreal nests differed along edges with different contrast (age of edge and degree of vegetative cover) and in relation to time period and nest height.

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## STUDY AREA

We conducted the study on a 212-ha sector of the BGMA, Centre County, Pennsylvania. The BGMA was managed for ruffed grouse by the Pennsylvania Game Commission, using an even-aged system of forest clearcutting. The 212-ha sector consisted of 53 contiguous, 4-ha blocks in aspen cover. Each block contained 4 1-ha (100- × 100-m) plots of different ages. Three plots/block were clearcut in a clockwise fashion during winter 1976-77 (plot A), 1980-81 (plot B), and during winters 1985-86 through 1987-

<sup>1</sup> Present address: School of Forestry, University of Montana, Missoula, MT 59812.

88 (plot C), respectively. A fourth (plot D) was uncut and contained overstory trees (>7.5 cm diam breast height [dbh] and  $\geq 1.5$  m tall) that were 60–65 years old. Major overstory trees in uncut plots included bigtooth aspen (*Populus grandidentata*), quaking aspen (*P. tremuloides*), and pitch pine (*Pinus rigida*). Principal understory trees ( $\leq 2.5$ –7.5 cm dbh) and shrubs (<2.5 cm dbh) in clear- and uncut plots were scrub oak (*Quercus ilicifolia*), dwarf chinkapin oak (*Q. prinoides*), quaking aspen, and blueberry (*Vaccinium* spp.)

Avian species nesting at or  $\leq 2$  m from ground level at the BGMA were wild turkey (*Meleagris gallopavo*), ruffed grouse, American woodcock (*Scolopax minor*), gray catbird (*Dumetella carolinensis*), ovenbird (*Seiurus aurocapillus*), golden-winged warbler (*Vermivora chrysopetra*), chestnut-sided warbler (*Dendroica pensylvanica*), common yellowthroat (*Geothlypis trichas*), rufous-sided towhee (*Pipilo erythrophthalmus*), and field sparrow (*Spizella pusilla*) (Yahner and Scott 1988). Potential predators on nests at the BGMA included snakes, American crow, blue jay, Virginia opossum (*Didelphis virginiana*), eastern chipmunk (*Tamias striatus*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and weasels (*Mustela* spp.) (Yahner and Scott 1988).

## METHODS

We randomly selected 15 interfaces of plots C and D (2-yr-old edges) and 15 interfaces of plots A and D (12-yr-old edges) in each of 6 time periods (trials) from mid-May to late July 1988. A trial was 5 days with 9 days between trials.

An artificial nest consisted of 2 fresh, brown chicken eggs (Yahner and Scott 1988). During a trial, a ground nest and an arboreal nest were placed 5 m into plot D along each 2- and 12-year-old edge and were separated 30–35 m (Yahner and Wright 1985). Ground nests were placed in leaf litter adjacent to logs, stumps, or overstory trees (Yahner and Wright 1985). Arboreal nests were put in cups (10 cm diam  $\times$  10 cm deep) formed with chicken wire, lined with leaf litter, and attached 1.5 m above ground to the nearest woody stem (1–5 cm dbh) (Yahner and Cypher 1987). We wore rubber gloves and boots when placing nests to minimize human scent (Nol and Brooks 1982). This experimental design gave a sample size of 60 nests/trial, with equal numbers ( $n = 15$ ) of ground and arboreal

nests (2 nests/edge) along 2- and 12-year-old edges.

We determined the fate (undisturbed, disturbed by an avian predator, or disturbed by a nonavian predator) of nests 5 days after placement. A disturbed nest had a broken or missing egg. Nest appearance and mode of disturbance were used to classify predators as avian or nonavian (Rearden 1951, Yahner and Scott 1988). Nests, eggs, and egg fragments were removed at the end of each trial (Yahner and Scott 1988). Numbers of potential avian predators, including American crows and blue jays, were counted within 200 m of artificial nests at time of placement and removal (Yahner and Scott 1988).

Vegetation associated with each nest was quantified at the end of each trial using a 0.40  $\times$  2.0-m density board equally divided into 5 0.40-m intervals above ground. We estimated the amount of vegetation covering each interval (to nearest 10%) at 3 locations: at the nest and 2 m to either side of the nest on a line parallel to the edge. Cover estimates were made by an observer (TEM) positioned along the edge interface and 5 m from the nest. Mean percent vegetative cover and coefficient of variation (CV) of the mean were calculated/nest, based on data combined from all levels at each of the 3 locations. The CV was used to express heterogeneity of vegetative cover at a nest. Thus, we expressed edge contrast as age of edge and the extent of vegetative cover.

The dependency of nest fate (successful vs. unsuccessful) on 4 variables, including age of edge (2- vs. 12-yr-old), vegetative cover ( $\bar{x} = \leq 33, 34$ –66, and  $\geq 67\%$  or  $CV = \leq 75$  and  $> 75\%$ ), time period (trials 1–6), and nest height (ground vs. arboreal), was examined by 5-way tests-of-independence (Dixon 1985:143). Likelihood ratios ( $G^2$ ) were computed to test for interactions of nest fate with other variables using log-linear models, which is appropriate for examining attribute variables in multi-way contingency tables (Sokal and Rohlf 1981:747, Dixon 1985:143). Yate's correction for continuity was added to each cell prior to analyses (Sokal and Rohlf 1981:736).

## RESULTS

One hundred forty-nine of 360 artificial nests (41%) were disturbed during the 6 trials (Table 1). Nest fate was independent of edge age ( $G^2 = 1.3, 1$  df,  $P = 0.522$ ), vegetative cover ( $\bar{x}$ :  $G^2 = 6.7, 4$  df,  $P = 0.153$ ; CV:  $G^2 = 2.2, 2$  df,  $P = 0.335$ ), and time period ( $G^2 = 7.2, 10$  df,  $P =$

Table 1. Fate of 360 artificial nests in relation to age of edge, vegetative cover, time period, and nest height (m), at the Barrens Grouse Habitat Management Study Area, Centre County, Pennsylvania, 1988.

Variable	Level	Nest fate					
		Undisturbed		Disturbed			
		n	% of total	Avian predator		Nonavian predator	
		n	% of total	n	% of total	n	% of total
Age of edge	2-yr-old	108	30	19	5	53	15
	12-yr-old	103	29	30	8	47	13
Vegetative cover	$\bar{x} \leq 33\%$	115	32	19	5	44	12
	$\bar{x} = 34-66\%$	79	22	26	7	49	14
	$\bar{x} \geq 67\%$	17	5	5	1	6	2
	CV $\leq 75$	155	43	39	11	68	19
	CV $> 75$	56	16	11	3	31	8
Time period	Trial 1	32	9	7	2	21	6
	Trial 2	36	10	7	2	17	5
	Trial 3	42	11	6	2	12	3
	Trial 4	32	9	7	2	21	6
	Trial 5	36	10	10	3	14	4
	Trial 6	34	9	12	3	14	4
Nest ht	Ground	123	34	11	3	46	13
	Arboreal	88	24	38	11	54	15

0.704). Forty-eight percent of the disturbed nests were located along 2-year-old edges, and 52% of the disturbed nests were along 12-year-old edges. Mean vegetative cover exceeded 33% at fewer undisturbed (45%) than disturbed nests (58%); CV was  $\geq 75\%$  at 27 and 28% of the undisturbed and disturbed nests, respectively. Numbers of nests disturbed/trial ranged from 18 (30%) in trial 3 to 28 (47%) in trials 1 and 4.

Nest fate was dependent only on nest height ( $G^2 = 12.9$ , 1 df,  $P < 0.001$ ), with 32% of the ground nests and 51% of the arboreal nests disturbed (Table 1). When nests lost to avian predators were separated from those lost to other predators, birds had a greater impact on arboreal nests ( $G^2 = 13.3$ , 2 df,  $P < 0.001$ ) than on ground nests. Nineteen percent of 57 disturbed ground nests and 42% of 91 disturbed arboreal nests were lost to avian predators. We recorded 4.8 crows/trial (range = 2.0–9.0) and 10.5 blue jays/trial (range = 0.0–11.5).

Vegetative cover was distinct between 2- and 12-year-old edges ( $\bar{x}$ :  $G^2 = 23.7$ , 2 df,  $P < 0.001$ ; CV:  $G^2 = 31.7$ , 1 df,  $P < 0.001$ ). For instance, mean vegetative cover  $> 33\%$  occurred more often along 12- (65%) than along 2-year-old edges (37%). Conversely, cover was more heterogeneous at 2- than 12-year-old edges, with a CV of  $> 75\%$  at more 2-year-old (41%) than 12-year-old edges (12%). Further, vegetative cover was related to time period ( $\bar{x}$ :  $G^2 = 39.2$ , 10 df,  $P < 0.001$ ; CV:  $G^2 = 25.2$ , 5 df,  $P < 0.001$ ), primarily

because of limited leaf-out during trial 1. Mean vegetative cover of  $> 33\%$  occurred at only 33% of the edges in trial 1 but increased to 70–83% in subsequent trials; CV was  $> 75\%$  at 53% of the edges during trial 1 and ranged from 10–23% during trials 2–6.

## DISCUSSION

We demonstrated that differences in edge contrast were not related to incidences of depredation on artificial nests. This suggests that the extent to which edges become "ecological traps" to nesting avifauna (Gates and Gysel 1978) may not be a function of edge contrast. Rather, we believe that incidences of nest predation along edges vary more with type of predator and nest height.

Angelstam (1986) noted that birds are principal predators of avian nests in forested habitats, whereas mammals are important predators on nests in farmland habitats. At the BGMA, corvids were suspected to be the major predators on nests (Yahner and Scott 1988, Yahner and Voytko 1989), perhaps because these predators are considered edge species (Whitcomb et al. 1981) and because the BGMA contains considerable edge as a result of clearcutting. Our study and others (Joern and Jackson 1983, Yahner and Scott 1988) have shown depredation was greater on arboreal than on ground nests. Arboreal nests are likely more conspicuous than ground nests to corvids perched in trees along interfaces of

uncut and clearcut plots. Shalaway (1985) found that 42% of natural nests along fencerows were lost to predators, with arboreal nests being somewhat less successful than ground nests.

Prior studies have shown that nest predation is inversely related to vegetation cover (Yahner and Wright 1985, Sugden and Beyersbergen 1986, Yahner and Cypher 1987). Yahner and Wright (1985), for example, found fewer incidences of nest predation in younger than in older clearcut or uncut stands at the BGMA, in part due to greater vegetative cover at ground level in younger stands. But in our study, relative differences in vegetation cover were probably less pronounced and were minimized among nest sites by placing nests only in uncut stands.

We conclude that at least in forested habitats, depredation of artificial avian nests is not affected by differences in edge contrast. Moreover, arboreal nests located along edges may be most susceptible to avian predators as amounts of edge increase in the future with continued forest fragmentation. With increases in the amounts of edge habitat via silviculture, urbanization, or other land uses, we and others (Ratti and Reese 1988, Yahner and Scott 1988, Yahner and Voytko 1989) recommend that more attention be given to experimental studies of depredation of avian nests (particularly arboreal) located along edges in various landscapes to better understand factors affecting long-term trends in avian population numbers (Whitcomb et al. 1981). However, we caution that artificial nests may be destroyed by predators at a greater rate than natural nests because adults associated with natural nests conceal eggs while incubating and often defend nests against potential predators (Angelstam 1986, Yahner and Voytko 1989).

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