The Effects of Fencelines on the Reproductive Success of Loggerhead Shrikes

REUVEN YOSEF*

Department of Zoology
The Ohio State University
Columbus, OH 43210, U.S.A. and
Archbold Biological Station
Lake Placid, FL 33852, U.S.A.

Introduction

The Loggerhead Shrike is important as an indicator species of environmental quality because of its exclusively predatory feeding habits and close association with agricultural areas. This shrike has been of special concern to conservationists for over two decades because it has undergone a steady decline in numbers since the turn of the century (Graber et al. 1973). Many factors have been implicated in the decline (see Anderson & Duzan 1978; Blumton 1989).

Numerous recommendations have been made for the enhancement of roadside grass strips and hedgerows for use by nesting birds (see Warner et al. 1987). Changes in agricultural practices and the subsequent loss of grasslands and hedgerows (Vance 1976) have lead to greater breeding densities in species that use fencerows as nest sites. Studies have found that these densities may be 10–30 times greater in fencerows than in more natural breeding habitat (Basore et al. 1986). To date, most studies have concentrated on the impact on game species of this human-induced breeding concentration in fencelines (see Warner et al. 1987). Lately, the use of such linear habitats has been documented for nongame species too, especially passerines (Basore et al. 1986).

One of the few passerine species so far studied in the context of linear habitats is the Loggerhead Shrike. Luukkonen (1987) found that shrikes nested closer to roadsides than expected, that the productivity of roadside pairs was half that of pairs breeding in other habitats, and that most losses were attributed to nest predation. DeGeus (1990) thought that linear habitats attracted birds to areas where heavy predation limited production to levels below those needed for replacement.

Fencelines on a working cattle ranch should be analogous to roadside hedgerows in that many "hedgerow-fenceline-nesting" species and their predators are concentrated at great densities. Also, cattlemen often prefer monoculture pastures, and thus trees and bushes are found almost exclusively along fencelines. Where nests of breeding species are concentrated in a linear fashion, it should be most profitable for a predator to search along such corridors. Such behavior by predators would result in a decrease in fitness levels of corridor-nesting prey species. I postulated that species nesting in fencelines are affected in a manner similar to those in other linear habitats (Santos & Telleria 1992). I tested the prediction that Loggerhead Shrike nests in trees and shrubs away from fencelines would suffer fewer losses from predation than would those in fenceline substrates.

Study Area and Methods

To assess the effects of linear habitats on Loggerhead Shrike reproductive success, I studied 27 breeding pairs

Paper submitted November 9, 1992; revised manuscript accepted April 5, 1993.

Present address: International Ornithological Center, P.O. Box 774, Eilat 88000, Israel.

during the 1992 breeding season (mid-February to mid-June) at the MacArthur Agro-ecology Research Center (MAERC) of the Archbold Biological Station, Florida. MAERC is a 4200-ha working cattle ranch with extensive Bahia-grass pastures. Barbed-wire fences bound the pastures. Through the years, cabbage palm (*Sabal palmetto*), live oak (*Quercus virginianus*), wax myrtle (*Myrcus cerifera*), and a few other species of trees and bushes have colonized these fencelines, creating a series of linear habitats that are used by shrikes for nesting. Numerous other bird species (such as Mockingbird, *Mimus polyglottos*, Northern Cardinal, *Cardinalis cardinalis*, Red-winged Blackbird, *Agelaius phoeniceus*, Boat-tailed Grackle, *Quiscalus major*, Rufous-sided Towhee, *Pipilo erythrophthalmus*) nested in fenceline vegetation during my study.

During the 1990 and 1991 breeding seasons, we trapped and banded shrikes for individual recognition with aluminum and color bands from the Fish & Wildlife Service. Color-marked shrike pairs were observed intensively during Spring 1992 in order to locate nests. Only those nests discovered within two days of the first egg being laid were included in the analysis, a procedure which greatly reduced uncertainty about the number of days of exposure to predation. Because predators were observed to forage up to 10 m away from fencelines, I classified nests as in a fencerow if they were situated within 10 m of a fenceline, and in pasture if situated beyond that distance. Snelling (1968) found that human visits to nests attracted predators. Therefore, I visited all nests at equal frequencies (every third day) to ascertain the stage of the reproductive cycle. Data were pooled for all pairs that nested in each of the two habitat types, so that probability of survival from the day an egg was laid to fledging could be calculated using Mayfield's exposure-day method (1961, 1975).

I searched the vicinity of depredated nests for signs of the predator. In all cases, I ascribed predation to mammals if the nest structure was damaged and to avian or reptilian predators if the nest was intact and only the contents were missing. In addition to examining habitat type as a factor influencing reproductive success, I checked for an effect of distance from fenceline on reproductive success, and on the proportion of eggs laid that was later lost to predation. I used each nesting attempt as an independent sampling unit and compared various measures of reproductive effort in an attempt to isolate incompetent pairs (at hiding or defending the nest) within a habitat and between habitats, to verify that no pair biased my analyses. Unless otherwise stated, data are presented as means ± SD. All percentages were arc-sine transformed prior to analysis. I employed simple regression and Chi-square tests for comparison of data from the two nesting habitats, and chose $p = 0.05$ as the minimum acceptable level of significance.

Results

During the 1992 breeding season, the first nest was initiated on February 19, and the nesting season ended on June 18 when the last successful brood fledged. The 27 Loggerhead Shrike pairs laid 64 clutches (four pairs laid more than one replacement clutch), of which 22 (34%) were renestings after a previous clutch had been lost to either predation or inclement weather, and 15 (23%) were second clutches after the first brood had successfully fledged. The overall nesting success was 51%. Predation accounted for 30 (86%) of the 36 nests destroyed. Mammals destroyed 21 (60%) nests, and avian or reptilian predators nine (26%) nests. Clutch size averaged 3.8 ± 0.8 eggs (range 2–5). A total of 245 eggs was laid, of which 113 (46%) hatched and 90 (37%) fledged (an average of 3.33 young/pair/season).

Sixteen pairs nested in fenceline vegetation. Nests were placed in cabbage palm, live oak, wax myrtle, blackberry (*Rubus betulifolius*), or southern elderberry (*Sambucus canadensis*). Of the 16 first clutches, nine were depredated and two were lost to inclement weather. Replacement clutches were laid within 10 days of loss. Thirteen of the 17 replacement clutches laid in fencelines were depredated. Five (31%) pairs successfully fledged two broods (Table 1). The average incubation period for successful nests was 15.1 ± 1.2 days, and the average nestling period for successful nests was 15.8 ± 0.8 days.

Of the 16 first clutches, 17 replacement and six second clutches (total 39 clutches) placed in fenceline vegetation, 25 failed during an aggregate of 412 nest-days during incubation, a daily mortality rate of 0.061 nests per day. Predation accounted for 22 nest failures, and three nests were destroyed by inclement weather. The probability of a clutch surviving from the day the first egg was laid until hatching was 39.0 ± 0.5%.

Nest mortality during the nestling period was 1.0%

Table 1. Reproductive success of Loggerhead Shrikes nesting in fencelines and pastures in south-central Florida in 1992.

Parameter	*Fenceline*	*Pasture*	*Combined*
Clutch size	3.6 ± 0.9 (39)	4.0 ± 0.8 (25)	3.8 ± 0.9
Incubation Period (days)	9.7 ± 4.6 (39)	11.9 ± 3.2 (25)	10.6 ± 4.2
Nestling Period (days)	5.0 ± 7.1 (39)	9.7 ± 7.6 (25)	6.8 ± 7.6
Nestlings/Nest	1.3 ± 1.8 (39)	2.6 ± 2.0 (25)	1.8 ± 2.0
Fledglings/Nest	0.9 ± 1.5 (39)	2.1 ± 1.9 (25)	1.4 ± 1.7
Fledglings/Pair	2.2 ± 2.6 (16)	4.8 ± 3.1 (11)	3.3 ± 3.1
Hatching Success	35.0 (53)	61.2 (63)	46.1
Fledging Success	26.0 (37)	38.8 (40)	31.4
% Nests that Fledged >1 Young	33.3 (13)	60.0 (15)	42.2
% Pairs that Fledged >1 Young	56.3 (9)	81.8 (9)	66.7

Data are presented as means ± SD, and sample sizes are in parentheses.

per nest-day, and the survival rate to fledging of young from a nest that had successfully hatched young was 92.0 ± 0.4%. The overall nest survival for a nest placed in a fencerow was 36%, and the daily survival rate was 94.0 ± 5.3%. The probability of an egg surviving to hatch was 13.0 ± 0.2%, and of a nestling fledging, 67.0 ± 1.8%. The overall production rate was 8.0 ± 0.5%.

Eleven pairs nested in trees or bushes that were dispersed in pastures. Nests were placed in blackberry bushes, cabbage palms, or southern elderberry. Of the 11 first clutches, four were depredated and two were lost to inclement weather. In all six cases, replacement clutches were laid within seven days. Two of five replacement clutches were depredated. Seven (64%) pairs successfully fledged two broods during the nesting season (Table 1). The average incubation and nestling periods for successful nests were 14.7 ± 0.5 and 15.6 ± 0.5 days, respectively.

Of the 25 nests placed in vegetation away from fencelines, seven failed during incubation. Daily mortality rate was 3% (318 nest-days). Predation accounted for the failure of eight nests, and two others were destroyed by inclement weather. The overall probability of a nest surviving to the hatching stage was 64.0 ± 22.6% (Table 2).

Nest mortality during the nestling period was 1.0% per nest-day, and the survival rate of nestlings was 85.0%. The cumulative nest survival for a nest placed away from fencerows was 54.0 ± 10.2%. The overall probability of an egg surviving the incubation period was 64.0 ± 30.1%, and of a hatched nestling fledging, 73.0 ± 28.8%.

The overall production rate for shrike nests in combined habitats was 40.0 ± 16.7%. The proportion of offspring preyed on was 0.62 in fencelines and 0.30 in pastures. Pasture eggs had a five-fold greater chance of survival than did fenceline eggs (40% versus 8%, Table 2). The probability of a nest surviving through the nesting cycle was greater for pasture nests (54% compared to 36%), probably because the probability of an egg surviving to the hatching stage in pastures was almost double that in fencelines (64% compared to 33%). Reproductive success increased significantly with distance from fencelines ($r^2 = 0.094$, 63 DF, $p = 0.0136$). Fledging success, once the nestling stage had been reached, was not very different between the two nesting habitats (86% compared to 73%). However, both the number of young fledged and the overall production were significantly greater for pasture nests (Chi square test, $p = 0.0001$).

In order to examine whether birds nesting in fencelines were of lower quality, various measures of reproductive effort were compared. No statistically significant differences were found between pairs in the two habitats in clutch size ($z = -0.8$, $p = 0.4236$), incubation period ($z = -0.9$, $p = 0.367$), nestling period ($z = -0.7$, $p = 0.5002$), or number of unhatched eggs ($z = -1$, $p = 0.3173$).

Discussion

These results support the hypothesis that Loggerhead Shrikes nesting away from linear habitats suffer fewer nest losses and therefore attain greater reproductive success than shrikes nesting in fencelines. The probability of nest survival for the pairs that nested out in pastures in south-central Florida was similar to data for natural habitats in 10 other studies (Table 3). However, the probability of nest survival for the pairs nesting in fencelines (36%) was the lowest documented. Also, a significant relationship existed between nest survivability and distance from the fenceline. These results indicate that pairs nesting in fencelines suffered greater predation than those in pastures.

An alternative explanation to the increased-predation

Table 2. Mayfield estimates of probabilities of survival per day for Loggerhead Shrike nests in fencelines and pastures in south-central Florida in 1992.

Parameter	*Fenceline*	*Pasture*
Daily Nest Survival (incubation)	0.94	0.97
Daily Nest Survival (nestling)	0.99	0.99
Cumulative Nest Survival	0.36	0.54
Daily Egg Survival	0.93	0.97
$P_{Egg\ Surviving\ Incubation}$*	0.39	0.62
$P_{Survival\ During\ Hatching}$	0.94	0.90
Daily Nestling Survival	0.98	0.99
% Nest Survival	0.67	0.73
Production*	0.08	0.42

Probabilities were calculated from 39 nesting attempts by 16 pairs in fencelines and on 25 attempts by 11 pairs in pastures. Production is the probability that eggs at the start of incubation will produce fledgings. Asterisks denote statistically significant differences.

Table 3. Percent nest survival for Loggerhead Shrikes in North America.

State	$P_{nest\ survival}$	*Source*
Alabama	43	Siegel 1980
Colorado	66	Porter et al. 1975
Florida (Pastures)	54	Present study
(Fencelines)	36	
(Total)	51	
Illinois	80	Graber et al. 1973
Illinois	72	Anderson and Duzan 1978
Indiana	57	Burton 1990
Minnesota	62	Brooks and Temple 1990
Missouri	69	Kridelbaugh 1982
New York	50	Novak 1989
Oklahoma	46	Tyler 1992
South Carolina	65	Gawlik 1988
South Carolina	75	Gawlik and Bildstein 1990
Virginia	62	Luukkonen 1987
Virginia	55	Blumton 1989

hypothesis for nests in fencelines is that the birds there were of low quality and had been excluded from better habitats by higher quality conspecifics. However, a comparison of nesting parameters (clutch size, incubation period, nestling period, unhatched eggs/nest; Table 1) showed no statistically significant differences between the pairs nesting in the two habitat patch types.

Goransson et al. (1975) found that nest predation was positively related to nest density and suggested that predator learning was one likely explanation for higher predation rates on more densely packed nests. Martin (1988) found that predators increased their searching intensity when they encountered an increasing frequency of nests containing eggs. These findings are reinforced by the fact that "systematic" predators use linear habitats as travel corridors and are thus able to find nests easily when they are at high densities (Crabtree et al. 1989). Although I have no quantitative documentation, I observed that most potential mammalian predators (such as raccoon, *Procyon lotor*, opossum, *Didelphis marsupialis*, bobcat, *Lynx rufus*), reptilian predators (such as indigo snake, *Drymarchon corais*, yellow rat snake, *Elaphe obsoleta*, corn snake, *E. guttata*), and avian predators (such as Audubon's Crested Caracara, *Polyborus plancus cheriway*, Barred Owl, *Strix varia*) of shrike eggs and nestlings in my study area walked or flew along fencelines, and they appeared to avoid crossing open pastures. Thus, even if not intentionally concentrating their search for nests in fencelines, they increased their chances of accidentally finding nests there. Crabtree et al. (1989) found that striped skunks (*Mephitis mephitis*) specifically searched for nests in linear strips. Audubon's Crested Caracaras perch on fencelines and intently follow the activities of parent shrikes to tending nests, apparently in an attempt to find the nest (James N. Layne, personal communication).

Although the combined reproductive success (51%) of Loggerhead Shrikes in this study is at the lower end of the results from other studies (Table 3), it is representative for the species. However, the nest success of fenceline pairs compared with that of pasture pairs (33% versus 60%) has important implications for conservation and management efforts.

In Florida, rapid conversion of natural habitats to pasture, and more recently to citrus groves, has created evolutionarily instantaneous changes in habitat structure and vegetation. Conversion to pasture increases linear habitats (fencelines and hedgerows) and reduces natural vegetation, forcing most tree- and shrub-nesting passerines to the only available habitat, the remaining fencelines and hedgerows. Such fencelines are the major travel corridors available to predator species (Crabtree et al. 1989), thus increasing the predation frequency on the nesting species.

In conclusion, this study illustrates that hedgerows and fencelines are not necessarily optimal or even adequate nesting habitat, contrary to some earlier assumptions. If we wish to preserve biodiversity in general, and Loggerhead Shrikes in particular, it is important to distinguish habitats that are "sinks" and to delineate the factors that make them so.

Acknowledgments

I gratefully acknowledge financial support from the Frank M. Chapman Award of the American Museum of Natural History, and research grants from the Animal Behavior Society and the American Ornithologist's Union. Comments of T. C. Grubb, Jr., K. Tarvin, T. A. Bookhout, A. S. Gaunt, J. Bart, E. G. Bolen, and an anonymous reviewer improved earlier drafts of this manuscript. This is contribution 14 of the MacArthur Agroecology Research Center of the Archbold Biological Station.

Literature Cited

Anderson, W. C., and R. E. Duzan. 1978. DDE residues and eggshell thinning in Loggerhead Shrikes. Wilson Bulletin. 90:215–220.

Basore, N. S., L. B. Best, and J. B. Wooley, Jr. 1986. Bird nesting in Iowa no-tillage and tilled crop-land. Journal of Wildlife Management 50:19–28.

Blumton, A. K. 1989. Factors affecting Loggerhead Shrike mortality in Virginia. M. S. thesis. Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

Brooks, B. L., and S. A. Temple. 1990. Dynamics of Loggerhead Shrike population in Minnesota. Wilson Bulletin 102:441–450.

Burton, K. M. 1990. An investigation of population status and breeding biology of the Loggerhead Shrike in Indiana. M.S. thesis. Indiana University, Bloomington, Indiana.

Crabtree, R. L., L. S. Broome, and M. L. Wolfe. 1989. Effects of habitat characteristics on Gadwall nest predation and nest-site selection. Journal of Wildlife Management 53:129–137.

DeGeus, D. W. 1990. Productivity and habitat preferences of Loggerhead Shrikes inhabiting roadsides in a midwestern agroenvironment. M.S. thesis, Iowa State University, Ames, Iowa.

Gawlik, D. E. 1988. Reproductive success and nesting habitat of Loggerhead Shrikes and relative abundance, habitat use, and perch use of Loggerhead Shrikes and American Kestrels in South Carolina. M.S. thesis. Winthrop College, Rock Hill, South Carolina.

Gawlik, D. E., and K. L. Bildstein. 1990. Reproductive success and nesting habitat of Loggerhead Shrikes and in north-central South Carolina. Wilson Bulletin 102:37–48.

Goransson, G., J. Karlsson, S. G. Nilsson, and S. Ulfstrand. 1975. Predation on birds' nests in relation to antipredator aggression and nest density: An experimental study. Oikos 26:117–120.

Graber, R. R., J. W. Graber, and E. L. Kirk. 1973. Illinois birds: Laniidae. Biology Notes 83, Illinois Natural History Survey, Urbana, Illinois.

Kridelbaugh, A. L. 1982. An ecological study of Loggerhead Shrikes in central Missouri, M.S. thesis. University of Missouri, Columbia, Missouri.

Luukkonen, D. R. 1987. Status and breeding ecology of the Loggerhead Shrike in Virginia. M.S. thesis. Virginia Polytechnic Institute, Blacksburg, Virginia.

Martin, T. E. 1988. On the advantage of being different: Nest predation and the coexistence of bird species. Proceedings of the Academy of Sciences 85:2196–2199.

Mayfield, H. 1961. Nesting success calculated from exposure. Wilson Bulletin 73:255–261.

Mayfield, H. 1975. Suggestions for calculating nesting success. Wilson Bulletin 87:456–466.

Novak, P. G. 1989. Breeding ecology and status of the Loggerhead Shrike in New York State. M.S. thesis. Cornell University, Ithaca, New York.

Porter, D. K., M. A. Strong, J. B. Giezentanner, and R. A. Ryder. 1975. Nest ecology, productivity and growth of the Loggerhead Shrike on the shortgrass praire. Southwest Naturalist 19:429–436.

Santos, T., and J. L. Telleria. 1992. Edge effects on nest predation in Mediterranean fragmented forests. Biological Conservation 60:1–5.

Siegel, M. S. 1980. The nesting ecology and dynamics of the Loggerhead Shrike in the blackbelt of Alabama. M.S. thesis. University of Alabama, Tuscaloosa, Alabama.

Snelling, J. C. 1968. Overlap in feeding habits of Red-winged Blackbirds and Common Grackles nesting in a cattail marsh. Auk 85:560–585.

Tyler, J. D. 1992. Nesting ecology of the Loggerhead Shrike in southwestern Oklahoma. Wilson Bulletin 104:95–104.

Vance, D. R. 1976. Changes in land use and wildlife populations in southeastern Illinois. Wildlife Society Bulletin 4:11–15.

Warner, R. E., G. B. Joselyn, and S. L. Eetter. 1987. Factors affecting roadside nesting by pheasants in Illinois. Wildlife Society Bulletin 15:221–228.