THE MAYFIELD METHOD FOR STANDARISATION OF SHRIKE BREEDING STUDIES: THE CASE OF THE LOGGERHEAD SHRIKE (*Lanius ludovicianus*) IN SOUTHCENTRAL FLORIDA

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ABSTRACT

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Loggerhead Shrike nesting ecology was studied in south-central Florida from 1991 to 1993. Completed nests were found from late December to mid May. Nesting peaked in mid March with second and/or third nestings attempted from late March to late May. Average length of the nesting season was seven weeks. Almost 60% of all nests were built in Blackberry Bushes (*Rubus betulifolius*), but Cabbage Palm (*Sabal palmetto*) and Wax Myrtle (*Myrica cerifera*) were also used frequently. Mean nest height was 1.6 m and average clutch size was 4.8 eggs. A mean of 17 days was required for incubation and the average fledging period was 15.1 days. Average hatching success was 87.7% and 80.6% of these fledged successfully. Majority of nest losses was due to predation and inclement weather. Average probability of survival using Mayfield's method was 38% (15.2 – 54.6%). Unlike conspecifics in northern latitudes where second or repeated nestings are considered rare, 96% of breeding pairs in Florida attempted second broods.

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Key words: Loggerhead Shrike, nesting ecology, Florida.

INTRODUCTION

The Loggerhead Shrike is important as an indicator species of environmental quality and degradation because of its exclusively predatory feeding habits and close association with agricultural areas (Hands *et al.* 1989). This shrike has been of

special concern to conservationists for over two decades (Arbib 1972, Hands *et al.* 1989), and has undergone a steady decline in numbers since the turn of the century (Hess 1910, Graber *et al.* 1973, Morrison 1981, Robbins *et al.* 1986). Many factors have been implicated in the decline (Busbee 1977; Anderson and Duzan 1978; Kridelbaugh 1982; Bystrak 1983; Cadman 1985; Brooks and Temple 1990a, 1990b; Hands *et al.* 1989; Lymn and Temple 1991; Cade and Woods 1997), however the common conclusion of many studies has been that recruitment of new individuals into the breeding population is not enough to offset the population mortality rate.

The Loggerhead Shrikes maintain territories throughout the year (Kridelbaugh 1983, Bohall-Wood 1988, Gawlik and Bildstein 1990, Howrey 1991, Yosef and Grubb 1992). Maintaining larger territories than other insectivorous passerines of similar size is probably a function of specialized foraging behaviour (Yosef 1996). Howrey (1991) considered habitat structure, number and dispersion of trees, degree of intraspecific competition and absolute prey abundance as factors that influence territory establishment. Bent (1950) thought that prey abundance dictated territory size. Yosef (1992) found that perch density influenced territory size, and this was further substantiated for Fiscal Shrikes (*L. collaris*) in South Africa (Devereux 1998), Great Grey Shrikes (*L. excubitor*) in Germany (Schön 1994), and has been a technique utilized for generations on Taiwan to trap Brown Shrikes (*L. cristatus*) (Severinghaus 1991). Yosef and Grubb (1992) discovered larger territories negatively influenced activity-budgets and nutritional condition. Unfortunately, the nesting ecology of stable population of Loggerhead Shrike remains relatively unstudied. Here, I present nesting ecology data on a resident Loggerhead Shrike population from south-central Florida, studied from 1991 through 1993.

METHODS

During 1991-93, I studied Loggerhead Shrike ecology at the MacArthur Agro-Ecology Research Center (MAERC) of the Archbold Biological Station, Highlands County, south-central Florida. MAERC is nearly equidistant from the Atlantic Ocean and Gulf of Mexico coasts and is a 4200 ha working cattle ranch that has extensive Bahia-grass pastures. Barbed wire fences bound the pastures. Through the years, Cabbage Palm, Live Oak, Wax Myrtle and a few other species of trees and bushes have colonized the fencelines, creating linear habitats that facilitate establishing of territories and are used by shrikes for nesting.

During 1990 and 1991 breeding seasons, I trapped shrikes (Yosef and Lohrer 1992) and ringed them for individual recognition with USFWS aluminium and colour rings. I used the shrikes' aggressive responses to playbacks and taxidermic mounts to map the borders of all territories on the ranch. All nest sites were marked on aerial photographs, and colour-marked shrike pairs were observed intensively in order to locate nests and to compile data pertaining to their ecological requirements (*e.g.* Yosef 1992, 1993, 1994; Yosef and Grubb 1992, 1993, 1994; Yosef and Whitman 1992). Snelling (1968) and Nol and Brooks (1982) found that human

visits to nests attracted predators. Therefore, I visited all nests at equal frequencies (every third day). During each visit, the nest was checked to ascertain the stage of the reproductive cycle (nest building, egg laying, incubation, hatching, nestling, fledging).

I recorded the dates of courtship behaviour and the way it was conducted, nest building and materials used, dates of egg laying, incubation, hatching, brooding and fledging. Other aspects, such as nesting substrate choice, parental behaviour and the effects of predation, inclement weather and human disturbance, were also recorded.

Based on my observations, I calculated nesting success (% of pairs that fledged at least one young), hatching success (% of eggs laid that hatched) and fledging success (% of young hatched that fledged) for three breeding seasons observed. Probability of survival from beginning of incubation to fledging was calculated using the Mayfield's (1961, 1975) exposure-day method. Survival probability per nesting attempt and per egg or nestling during the hatching, nestling and fledging stages were also determined. I calculated the daily survival rates of nests using the average of 17 days for the egg laying and incubation period and 15 days for the nestling stage (based on Table 1).

Table 1
Mayfield estimates of probabilities of survival per day for Loggerhead Shrike nests in southcentral Florida during the 1991-1993 breeding seasons. Production is the probability that eggs at the start of incubation will produce fledglings

	1991	1992	1993	Average
N breeding pairs	23	27	23	
N nesting attempts	49	64	39	
Clutch size	4.8	3.8	4.3	4.3
Incubation period (days)	19.2	14.9	16.8	17.0
N eggs laid	240	123	164	
N eggs hatched	200	113	144	
N young fledged	161	89	119	
Brooding period (days)	14.5	15.7	15.2	15.0

Daily nest survival:				
Nest-incubation	0.86	0.50	0.88	0.75
Nest-nestlings	0.92	0.90	0.93	0.91
Per egg	0.83	0.47	0.89	0.73
Per nestling	0.82	0.78	0.85	0.82
p-egg survival	0.71	0.24	0.78	0.58
p-hatching survival	0.83	0.92	0.88	0.88
p-nestling survival	0.75	0.69	0.79	0.75
Production	**0.44**	**0.15**	**0.55**	**0.38**

Many potential nest predators occurred in the study site and were either observed at nest sites or in the vicinity (Yosef and Yosef 1992). These included Racoon (*Procyon lotor*), Opossum (*Didelphis marsupialis*), Bob-cat (*Lynx rufus*), Red Fox (*Vulpes fulva*), Indigo Snake (*Drymarchon corais*), Yellow Rat Snake (*Elaphe obsoleta*), Corn Snake (*E. guttata*), Audubon's Crested Caracara (*Caracara cheriway*) and American Crow (*Corvus brachyrhynchos*). 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.

Unless otherwise stated, data are presented as means ± *SD*, and chose $p = 0.05$ as the minimum acceptable level of significance.

RESULTS

The breeding season was normally from mid February to mid June, but exceptional pairs were observed to initiate nesting in early January. However, because some „higher quality" pairs nested in quick sequence, or early-failing pairs initiated second clutches, before later pairs initiated first ones, date of clutch initiation did not consistently distinguish between first and second, or other subsequent, clutches in this population (Fig. 1). A total of 23 pairs were observed for each of the 1991 and 1993 breeding seasons and 27 pairs during the 1992 season. Averaging of breeding activity of all three seasons per day shows that two peaks of breeding activity occurred: 27 January-4 February and 20 March-11 April. A third, smaller peak of activity is observed in the second half of May and comprises mostly of replacement clutches or second or subsequent breeding attempts. The breeding period stretched over 26 weeks, *i.e.* 6.5 months and usually ended before the onset of the summer

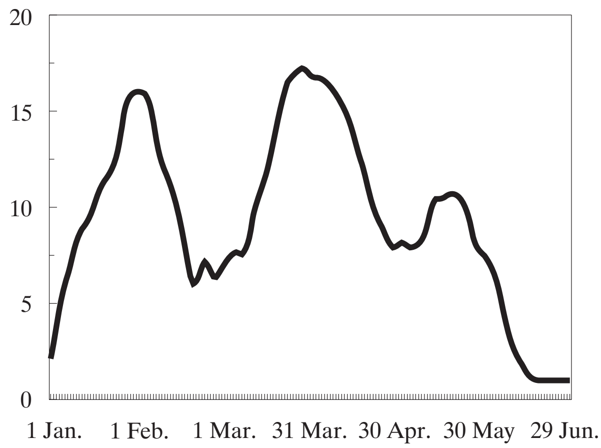

Fig. 1. Average number of active nests per date as an index of seasonal reproductive activity of Loggerhead Shrikes in southcentral Florida for the 1991-1993 breeding seasons (smoothed by moving average).

rains. During 1991, 49 nesting attempts were discovered, during 1992 – as many as 64 attempts, and in 1993 – only 39 attempts. The 1992 season was cut short owing to an unpleasant episode, wherein most of the nests were destroyed (Yosef and Deyrup 1998). These were not included in the data analyses of the Mayfield analyses.

The Loggerhead Shrike is mostly monogamous, however polygyny was found in the duration of this study (Yosef 1992). While courtship, the male feeds the female and performs the dance accompanied by special repertoire of vocalizations (Yosef 1996). The male also performed flight displays about 7 m from the female, and mock pursuits were observed (*cf.* Ehrlich *et al.* 1988).

The Loggerhead Shrike nested earlier in the year than most sympatric passerines (Yosef 1996). Both parents were observed to cooperate in the building of the nest structure, and took on average a week to build. The nest was usually well hidden just below the crown of the tree or the bush, or in the crotch of two branches, or in the foliage on a large branch. The nests were bulky, well made of rootlets, twigs, forbs, and bark strips woven together. The inside cup was lined with soft material that included flowers of annuals, grasses, feathers, fur of road-killed mammals, or human-made material, like string or cloth.

The outer diameter of the nest was in average 152 mm, the inside diameter – 102 mm, and the depth of the nest cup – 76 mm (N = 9)(Yosef 1996). Nests were reused occasionally, probably by the same pairs in subsequent seasons. Material from old nests is sometimes incorporated into new nests, especially if they are from the same season (Yosef 1996).

The eggs are greyish-buff, marked with dark colours near the large end. The average mass of fresh, whole egg was 4.43 g (range 3.69-5.00, N = 14 clutches, 78 eggs) (Yosef 1996).

During the 1991 breeding season, the first nest was initiated on 9 March and the nesting season ended on 2 July when the last successful brood fledged. The 23 Loggerhead Shrike pairs laid 49 clutches, of which 5 (10%) were renestings after a previous clutch was lost, and 21 (43%) were second or third clutches after the first

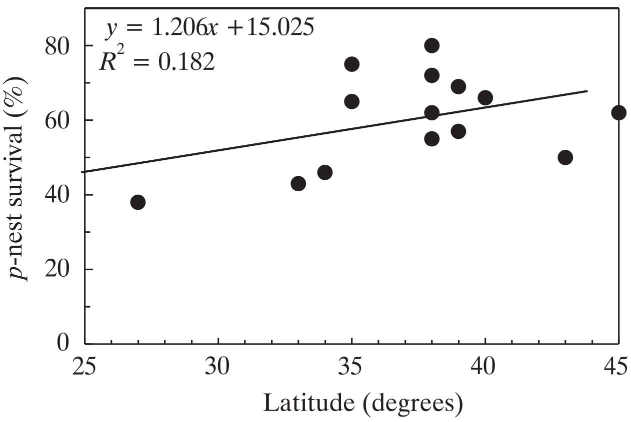

Fig. 2. Probability of nest survival versus latitude.

brood had successfully fledged. 21 (43%) nests became destroyed and predation accounted for 9 of them. Mammals destroyed 5 (10%) of all nests and avian or reptilian predators – 4 (8%) nests. Inclement weather destroyed additional 12 (25%) of the active nests. Clutch size ranged from four to five eggs and averaged 4.8 ± 0.4. A total of 240 eggs was laid, of which 200 (83%) hatched, and 161 (81%) fledged, *i.e.* an average of 7.0 young/pair/season. The probability of an egg surviving the incubation period to hatch was 0.708, of surviving during the hatching period – 0.833, and of the hatchling surviving the brooding period to fledge – 0.75. The overall probability of survival of an egg laid to successfully fledge a young during the season was 0.442, *i.e.* 44.2%.

During the 1992 breeding season, the first nest was initiated on 19 February and the nesting season ended on 18 June, when the last successful brood fledged. The 27 Loggerhead Shrike pairs laid 64 clutches, of which 22 (34%) were renestings after a previous clutch had been lost, and 15 (23%) were second clutches after the first brood had successfully fledged (Table 1). 36 (56%) nests became destroyed and predation accounted for 30 of them. Mammals destroyed 21 (33%) of all nests, and avian or reptilian predators – 9 (14%) nests. Inclement weather destroyed additional 6 (9%) of the active nests. Clutch size ranged from two to five eggs and averaged 3.8 ± 0.8. A total of 123 eggs was laid, of which 113 (92%) hatched, and 90 (80%) fledged, *i.e.* an average of 3.33 young/pair/season. The probability of an egg surviving the incubation period to hatch was 0.238, of surviving during the hatching period – 0.919, and of the hatchling surviving the brooding period to fledge – 0.695. The overall probability of survival of an egg laid to successfully fledge a young during the season was 0.152, *i.e.* 15.2%.

During the 1993 breeding season, the first nest was initiated on 2 January and the nesting season ended on 8 June when the last successful brood fledged. The 23 Loggerhead Shrike pairs laid 39 clutches, of which 12 (31%) were renestings after a previous clutch had been lost, and 4 (10%) were second clutches after the first brood had successfully fledged. 12 (31%) nests became destroyed and predation accounted for 10 of them. Mammals destroyed 3 (8%) of all nests, and avian or reptilian predators – 7 (18%) nests. Inclement weather destroyed additional 2 (5%) of the active nests. Clutch size ranged from two to six eggs and averaged 4.3 1.0. A total of 164 eggs was laid, of which 144 (88%) hatched, and 119 (83%) fledged, *i.e.* an average of 5.0 young/pair/season. The probability of an egg surviving the incubation period to hatch was 0.785, of surviving during the hatching period – 0.878, and of the hatchling surviving the brooding period to fledge – 0.79. The overall probability of survival of an egg laid to successfully fledge young during the season was 0.546, *i.e.* 54.6%.

The majority of 152 nests was placed in Blackberry Bushes (*Rubus betulifolius*) – 91 (60%). Nests were also placed in Cabbage Palm – 33 (22%), Live Oak – 17 (33%), Wax Myrtle – 8 (5%) or Southern Elderberry (*Sambucus canadensis*) – 3 (2%).

DISCUSSION

The results of three reproductive seasons in a stable population in south-central Florida illustrates that there is a great degree of fluctuation in breeding success between years. The major factors contributing to these fluctuations are mostly natural stochastic events (Table 1). Anthropogenic disturbance encountered in this study has usually had detrimental effects, in most encounters being terminal (see Yosef and Deyrup 1998), and is not included in this study. A comparison on the continental scale to other studies shows that, unlike clutch size (Yosef 1996), there is no latitudinal cline of nesting success of Loggerhead Shrikes (Table 2, linear regression $R^2 = 0.1597$, $p = 0.128$).

The probability of survival between years of a nest at the incubation stage is consistently the lowest in comparison to the hatching and nestling stages of the reproductive cycle (Table 1). A comparison of nest loss shows that more nests were preyed upon, at a ratio of about 2.5 : 1, in comparison to those lost because of inclement weather (49 to 20) out of the 152 attempts. Raccoons were the most common and accounted for 29 of the predations.

The placement of majority of the nests in Blackberry Bushes in the middle of pastures, away from fenceline vegetation, stresses the importance of educating the public to allow random bushes and trees to grow in open pastures in order to allow a semblance of the natural avian heritage to survive. Numerous recommendations have been made for the enhancement of roadside grass strips and hedgerows for use by nesting birds (*e.g.* Joselyn *et al.* 1968, Leedy 1975, Warner *et al.* 1987, Lymn and Temple 1991, Warner 1992). Changes in agricultural practices (*e.g.* an increase in field size as a result of modern mechanization and the application of pesticides) and the subsequent loss of grasslands and hedgerows (Mohlis 1974, Vance 1976, Moller 1983) have led 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, Bryan 1990). To date, most studies have concentrated on the impact of this human-induced breeding concentration on game species, *e.g.* Northern Bobwhite (*Colinus virginianus*) – Kabat and Thompson 1963; Greater Prairie Chicken (*Tympanuchus cupido*)– Kirsch 1974; Ring-necked Pheasant (*Phasianus colchicus*)– Warner *et al.* 1987.

Lately, the use of such linear habitats has been documented for non-game species too, especially passerines (Basore *et al.* 1986, Bryan 1990). One of the few passerine studied in the context of linear habitats is the Loggerhead Shrike (DeGeus 1990, Yosef 1994). Luukkonen (1987) and Burton and Whitehead (1990) found that shrikes nested closer to roadsides than expected. Further, the productivity of roadside pairs was half that of pairs breeding in other habitats and most losses were attributed to nest predation (*cf.* Ricklefs 1969). DeGeus (1990) thought that linear habitats attracted birds to areas where heavy predation limited production to levels

that were below those needed for replacement and thought that this may have contributed to the decline of shrikes in the Midwest.

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. In addition, cattlemen prefer monoculture pastures, and thus vegetation is restricted to fencelines. If nests of breeding species are concentrated in a linear fashion, it will be most profitable for a predator to search. Such behaviour of predators would result in a decrease in fitness levels of corridor nesting prey species (*cf.* Yosef 1994).

The above recommendations, in addition to preservation of existing grasslands, especially those used during the nonbreeding season is necessary to maintain shrike populations (Brooks 1988, Yosef 1994). Implementation of the above recommendations is problematic because grasslands are considered prime realty for urban areas, farming, ranching, golf courses, *etc.* In addition, early to mid successional grasslands are overlooked in management plans that usually concentrate on early successional habitat (Hands *et al.* 1989). To date, we are unaware of specific areas targeted for conservation of Loggerhead Shrikes.

Table 2
Percent nest survival for Loggerhead Shrikes in North America

State	Approx. location	*p*-nest survival (%)	Source
Florida	27°N, 81°W	38	Present study
Alabama	33°N, 88°W	43	Siegel 1980
Oklahoma	34°N, 98°W	46	Tyler 1992
S. Carolina	35°N, 81°W	75	Gawlik and Bildstein 1990
	35°N, 81°W	65	Gawlik 1988
Virginia	38°N, 50°W	62	Luukkonen 1987
	38°N, 79°W	55	Blumton 1989
Illinois	38°N, 89°W	80	Graber *et al.* 1973
	??	72	Anderson and Duzan 1978
Indiana	39°N, 86°W	57	Burton 1990
Missouri	39°N, 92°W	69	Kridelbaugh 1982
Colorado	40°N, 106°W	66	Porter *et al.* 1975
New York	43°N, 75°W	50	Novak 1989
Minnesota	45°N, 95°W	62	Brooks and Temple 1990a

Although the combined reproductive success (38%) of Loggerhead Shrikes in this study is the lowest of the results from other studies (Table 2), the species does not appear to have a fecundity problem at a reproduction rate of 5.1 young/pair/season. However, little is known about first year survivability in the species and it could be the weak point in the chain of recruitment leading to declines. The understanding of this critical parameter should be the focus for future studies.

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