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# NESTING ECOLOGY OF THE LOGGERHEAD SHRIKE IN SOUTHWESTERN OKLAHOMA

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ABSTRACT.—Loggerhead Shrike (*Lanius ludovicianus*) nests were studied in southwestern Oklahoma from 1985 through 1988. Pairing began in late February to early March, and completed nests were found from 13 March to 20 June. Nesting peaked in mid-April, with second nestings from late May to late June. Average length of the nesting season was 11 weeks. Almost one-third of all nests were built in Osage orange (*Maclura pomifera*) trees, but netleaf hackberry (*Celtis reticulata*), Chinese elm (*Ulmus pumila*), and eastern red cedar (*Juniperus virginiana*) were also used frequently. Mean nest height was 3 m, and average clutch size was 5.8. At least one egg hatched in 84% of clutches. A mean of 16.9 days was required for incubation and the average fledging period was 16.8 days. Probability of survival using Mayfield's (1961, 1975) method was 46%. *Received 30 July 1990, accepted 15 Sept. 1991.*

National Audubon Society Christmas Bird Counts and United States Fish and Wildlife Service (USFWS) Breeding Bird Surveys indicate that the Loggerhead Shrike (*Lanius ludovicianus*) has been extirpated or is rare throughout much of the eastern United States. It has been on the *American Birds* Blue List since 1971 (Arbib 1971, Tate 1986), and a status survey is being conducted by the USFWS. Possible explanations usually suggested for the shrike's decline are pesticides (Erdman 1970, Anderson and Duzan 1978, Kridelbaugh 1981, Phillips 1986), loss of nesting habitat (Graber et al. 1973), and intensive farming practices (Kridelbaugh 1982). The shrike is still common in Oklahoma (Droege and Sauer 1990). However, its numbers continue to decline at the rate of about 5% a year along fully 75% of the Oklahoma routes where it has been detected (USFWS, unpubl. data). There is little information available on the breeding ecology of the Loggerhead Shrike in the southern Great Plains. The present four-year study was undertaken in the spring of 1985 with the objective of contributing basic reproductive data from this part of the species' range.

## STUDY AREA

The study area was within a 24-km radius of Lawton, Comanche County, southwestern Oklahoma, in the mixed-grass plains biotic district of Blair and Hubbell (1938). Most area soils have been derived from the underlying Permian redbeds. Average elevation is approximately 350 m. Pasturelands interspersed with cultivated fields predominated, many of the former covered more or less by mesquite (*Prosopis juliflora*) or scattered small trees of various kinds. Occasional farmstead plantings and Osage orange (*Maclura pomifera*) hedgerows were common. The level to gently rolling terrain was dotted with numerous

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stockponds and irregularly dissected by intermittent streams. Many of these were bordered by riparian woodlands and the largest, East Cache Creek, bisected the research area. Ranching was the primary local enterprise, with winter wheat, hay, and cotton the major crops.

The climate is of the temperate continental type, with great fluctuations in both moisture and temperature from year to year. Rapid weather changes are common. Precipitation in Lawton averages about 80 cm per year, and the mean January and July temperatures, respectively, are 4.6 and 27.5°C.

## METHODS

When shrikes started to pair in late winter and early spring, former nest sites and other localities in suitable habitat were visited every two or three days until nest construction had begun or the site was abandoned. Thereafter, nests were checked at three- to six-day intervals until time of hatching or fledging neared, when more frequent visits were made. Data for 109 nests (28 in 1985, 27 in 1986, 26 in 1987, and 28 in 1988) were pooled so that probability of survival from onset of incubation to fledging could be calculated using Mayfield's (1961, 1975) exposure-day method. For nests that contained full clutches, or that fledged young, but for which the exact number of days of incubation or days as nestlings was not available, known averages from other nests found the same year were used. The probabilities of nest survival during the hatching period (two days) and during the nestling period were also determined. The known average nestling period for each year was assigned to other nests that fledged young that year, but for which exact data were not available (7, 11, 7, and 10 nests, respectively, by year).

## RESULTS

Twenty-three species of dense woody plants, most less than 6 m tall and usually isolated or in hedgerows, were selected as nest sites. Placement of nests frequently varied from year to year in a given territory but were usually within 100 m of the previous year's nest. The mean height for 128 nests was 2.97 ± 0.16 m. The principal trees used for nesting in southwest Oklahoma and the average percent of total nests contained in each were: Osage orange (31), hackberry (*Celtis reticulata*) (13), Chinese elm (*Ulmus pumila*) (11), and eastern red cedar (*Juniperus virginiana*) (9). Seven other woody plants contained from 3.0% to 5.5% of all nests, and 12 additional species held nests only once (Table 1).

During the four nesting seasons from 1985 to 1988, 133 nesting pairs were located. The nesting season, from initial nest construction until the last fledglings could fend for themselves, lasted about 12 weeks in 1985, 10 in 1986, 9 in 1987, and 13 in 1988. The overall average was 11 ± 1.8 weeks.

Pairing began from late February to mid-March, as winter territories broke down and some birds began to arrive from the south. Extreme dates for first evidence of nest construction during the study were February 23 and March 15, and the earliest egg was discovered on March 13. Peak nesting occurred about the first week of April (Fig. 1), and by May 2, 78 of 88 nests (89%) held complete clutches. A smaller second period of

TABLE 1

SPECIES OF TREES AND SHRUBS IN WHICH 133 SHRIKE NESTS WERE BUILT IN SOUTHWESTERN OKLAHOMA, 1985–1988

| | 1985 | | 1986 | | 1987 | | 1988 | | Total no. | Overall avg. |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | | |
| Osage orange (*Maclura pomifera*) | 8 | 22.0 | 7 | 22.6 | 13 | 42.0 | 13 | 36.1 | 41 | 30.7% |
| Hackberry (*Celtis reticulata*) | 6 | 17.0 | 5 | 16.0 | 3 | 9.7 | 3 | 8.3 | 17 | 12.8% |
| Chinese elm (*Ulmus pumila*) | 6 | 17.0 | 5 | 16.0 | 2 | 6.4 | 2 | 5.5 | 15 | 11.2% |
| Red cedar (*Juniperus virginiana*) | 4 | 11.0 | 2 | 6.4 | 4 | 12.9 | 2 | 5.5 | 12 | 9.0% |
| Mulberry (*Morus* sp.) | 4 | 11.0 | — | — | — | — | 4 | 11.1 | 8 | 5.5% |
| American elm (*Ulmus americana*) | 1 | 2.9 | 2 | 6.4 | 2 | 6.4 | 1 | 2.8 | 6 | 4.6% |
| Chittamwood (*Bumelia lanuginosa*) | 1 | 2.8 | — | — | 4 | 12.9 | 1 | 2.8 | 6 | 4.6% |
| Cottonwood (*Populus deltoides*) | — | — | 2 | 6.4 | — | — | 1 | 2.8 | 3 | 4.6% |
| Black willow (*Salix nigra*) | 3 | 8.0 | 3 | 9.7 | — | — | — | — | 6 | 4.4% |
| Black locust (*Robinia pseudo-acacia*) | — | — | 1 | 3.2 | 1 | 3.2 | 2 | 5.5 | 4 | 2.9% |
| Hawthorne (*Crataegus* sp.)[a] | 2 | 5.5 | 1 | 3.2 | 1 | 3.2 | — | — | 4 | 2.9% |

[a] Plus 12 other species used only once.

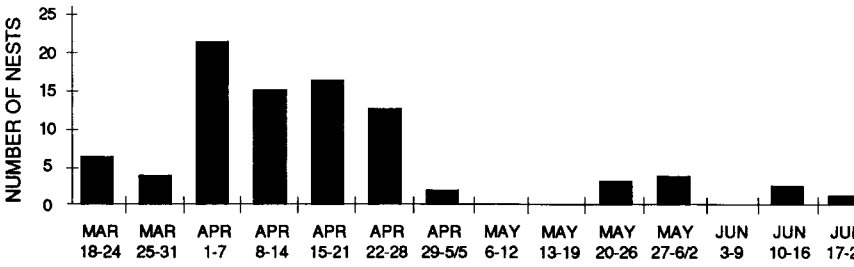


FIG. 1. Dates that 88 shrike nests were completed in Oklahoma, 1985–1988.

breeding activity took place between May 21 and June 20, when clutches in the remaining 10 nests were filled. Most of these were second broods, however, and there was no "peak." Dates for the last egg of the final clutch each year were June 18, 1, 10, and May 31; the average date was June 8.

First eggs for each of the four respective years were deposited on March 20, 13, 30, and 26. Earliest completed clutches were recorded on March 21, March 18, April 4, and March 31. Dates of first hatching were April 6, 3, 19, and 16.

Table 2 summarizes reproductive success for all four years. At least one egg hatched in 92% of all nests that contained eggs in 1985. This increased to 95% in 1986, fell to 69% in 1987, and rose to 81% in 1988 (Table 2). The overall mean percentage was 84%. The percentage of 133 nests fledging at least one young, although only 46% in both 1985 and 1987, was 63% in 1988 and 83% in 1986. The four-year average was 60%.

Clutch size ranged from three to seven eggs and averaged 5.8 for 101 nests. The mean was 5.7 in 1985, 5.6 in 1986, and 5.9 in 1987 and 1988.

The length of incubation (penultimate egg = day one) ranged from 16.6 days in 1988 to 17.1 in 1985. The four-year mean among 55 nests was 16.9 days. For nestlings in 28 nests with data, the average time from hatching to fledging was 16.8 days.

Ten of 37 pairs (27%) studied in 1985 attempted second broods, nine of 28 pairs (32%) in 1986, only two among 26 pairs (7.7%) did so in 1987, and three of 31 pairs (9.7%) in 1988. The overall average for all pairs was 19.1%. At one location, shrikes built second nests during the first three years only. At two nest sites, the same pair renested every year except 1987, and in 1986 one pair of birds incubated eggs in three successive nests. Second clutches were initiated from mid-April to mid-June. Out of 18 eggs laid in second nests, a maximum of three young fledged. Only three nesting territories were used all four years.

Nineteen of 109 nests failed while being exposed for 1663 days during

## TABLE 2

REPRODUCTIVE SUCCESS OF LOGGERHEAD SHRIKES IN SOUTHWESTERN OKLAHOMA, 1985–1988

| Year | Clutch size | | Incubation period (days) | | Hatching success[a] | | Nestling period (days) | | Fledging success[b] | | Attempted second broods | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | $\bar{x} \pm SD$ | N | $\bar{x} \pm SD$ | N | % | N | $\bar{x} \pm SD$ | N | % | Pairs | % |
| 1985 | 28 | 5.7 ± 0.86 | 8 | 17.1 ± 0.66 | 37 | 92 | 2 | 15.5 ± 2.00 | 41 | 46 | 37 | 27.0 |
| 1986 | 24 | 5.6 ± 0.88 | 15 | 16.9 ± 0.26 | 38 | 95 | 3 | 17.3 ± 0.71 | 35 | 83 | 28 | 32.0 |
| 1987 | 24 | 5.9 ± 0.62 | 19 | 16.9 ± 0.75 | 26 | 69 | 8 | 17.1 ± 2.10 | 26 | 46 | 26 | 7.7 |
| 1988 | 24 | 5.9 ± 0.29 | 13 | 16.6 ± 0.76 | 32 | 81 | 15 | 17.3 ± 1.54 | 32 | 63 | 31 | 9.7 |

[a] At least one egg hatched.
[b] At least one young fledged.

incubation for a daily mortality rate of 1.1% per nest-day. Daily nest survival rate was therefore 98.9%. Predation was suspected to have caused the failure of 10 nests, six were deserted, and three others were destroyed by high winds. Because the average incubation period for 55 nests was 16.9 days, successive survival rate was calculated for each day of incubation ($98.9^{17}$). Thus, the number of nests expected to remain if 1.1% of 109 nests were lost daily for 17 days was 94 (93.9%).

The hatching period in shrikes in normally two days, but the date that the first egg began to hatch was considered the final day of incubation for that nest. Only 468 of 619 eggs present at hatching time produced nestlings within two days of the onset of hatching, giving a probability of survival during the hatching period of 76%.

Of 90 nests observed during the nestling period, 27 failed during 1308 days of exposure, for a mortality rate of 2.1%. Therefore, the daily survival rate for nestlings was 97.9%. Because 16.8 days (rounded to 17) are required on average before nestlings leave the nest, the overall nestling survival rate was 64% ($97.9^{17}$).

Probability of survival of any nest from the start of incubation until the young had fledged was then computed: $0.94 \times 0.76 \times 0.64 = 0.46$, or 46%. Therefore, of 109 nests in which incubation was begun, the probability that any one would fledge at least one young bird was 46%.

## DISCUSSION

The average nest height in southwestern Oklahoma (N = 128) was 2.97 $\pm$ 0.16 m. In Missouri and Alabama, the average was slightly higher, 3.2 m (Kridelbaugh 1983) and 3 m (Siegel 1980), respectively, but in Colorado (Porter et al. 1975) it was only 2 m. Graber et al. (1973) also found that 88% of shrike nests were built in Osage oranges in northern and central Illinois, and in Kansas, too, this species was used for nesting more than any other (Johnston 1964). However, red cedar held the largest percentage of nests in Missouri (Kridelbaugh 1983), Alabama (Siegel 1980), Virginia (Luukkonen 1987), and South Carolina (Gawlik and Bildstein 1990). In Colorado, Porter et al. (1975) found that elms, willows (*Salix* sp.), cottonwoods (*Populus* sp.) and Russian olive (*Elaeaganus angustifolia*) supported 70% of all shrike nests.

As in Oklahoma, shrikes in Missouri (Kridelbaugh 1983) began to arrive and set up breeding territories during mid-February, and the earliest completed nest was found there on March 23, compared to March 13 in Oklahoma. The earliest active nest in South Carolina was discovered on 17 March (Gawlik and Bildstein 1990). Egg-laying was not initiated in Colorado until the first week in May (Porter et al. 1975). Peak nesting activity in Missouri and Illinois (Kridelbaugh 1983, Graber et al. 1973)

was in late April, with a second peak in late May in Missouri. Height of breeding in Alabama was in early April (Siegel 1980), as was the case in Oklahoma (Fig. 1). Porter et al. (1975), however, reported most nesting during late May in the higher latitudes of Colorado.

Hatching success for all years in Oklahoma varied from 69% in 1987 to 95% in 1986, averaging 81% (Table 2). Hatching at most Oklahoma nests took place around the first week of May. During the two years that success was highest (1985, 1986), April was exceptionally wet. The converse was true in 1987 and 1988, and hatching success was not as high. In 1988, when precipitation was only slightly below average but evenly distributed, success was greater than in 1987. However, only 2.0 mm of rain fell in April 1987, versus the norm of 63.5 mm (U.S. Weather Service, Fort Sill, Oklahoma). The two years of highest hatching success were also those with the greatest number of second nesting attempts (Table 2). This 81% average hatch success in Oklahoma is very close to the 79.5% found in Colorado (Porter et al. 1975). For 43 Missouri nests during two years, Kridelbaugh (1983) reported a mean of 85%.

For all four years, an average 60% of all nests fledged at least one young bird. The range was 46% to 83%. A majority of young shrikes fledged during mid to late May in Oklahoma. Poor success in both 1985 and 1987 was probably attributable to inclement weather. Heavy rains, high winds, and low temperatures in April 1985 were followed by inordinate dryness in May and local flooding in early June. In 1987, on the other hand, April was a month of extreme drought. The pendulum swung to the other extreme again during the last two weeks of May, when 279 mm of rain fell, 203 mm of it within one 96-h period (U.S. Weather Service, Fort Sill, Oklahoma). During this deluge, one to four nestlings were lost from five different nests. The Oklahoma mean of 60% is in close agreement with Kridelbaugh's (1983) of 59.4% for 43 nests in Missouri. The figures from Alabama (50%) and Colorado (55.9%) were somewhat lower (Siegel 1980, Porter et al. 1975).

For 101 Oklahoma nests, the average clutch size was 5.8. During the first two years of the study, in which both hatching success and attempts at second broods were at their highest levels, clutch size averaged 5.6 and 5.7, respectively, whereas the mean size during the other two years was 5.9 (Table 2). This overall Oklahoma average of 5.8 was the same as that for 34 nests in Minnesota (Temple and Brooks 1986). It ranged from 5.1 ($N = 57$) in Virginia (Luukkonen 1987) to 6.4 ($N = 65$) for Colorado (Porter et al. 1975) and is very near the 5.7 average found in both Missouri ($N = 55$) and Illinois ($N = 134$) (Kridelbaugh 1983, Graber et al. 1973). The mean clutch size of 32 Kansas nests, however, was only 5.3 (Johnston 1964).

The mean incubation period for Oklahoma shrikes was 16.9 days among 55 nests, which corresponds to Lohrer's (1974) average for 16 nests in Florida, and is almost identical to that for Missouri, where Kridelbaugh (1983) found it to be 17 days for 13 nests. For 14 California nests, this average was 16 days, as it was in Colorado (Miller 1931, Porter et al. 1975).

At 28 nests in Oklahoma, the nestling period averaged 16.8 days. Similarly, it averaged 17.6 days in Alabama and 17 for both Colorado and Florida (Siegel 1980, Porter et al. 1975, Lohrer 1974). This figure was 19 days for 14 Missouri nests (Kridelbaugh 1983) and 20 in California (Miller 1931).

In Oklahoma, the percentage of shrike pairs that attempted two broods ranged from 7.7% in 1987 to 32% in 1986. The average was 19.1%. As seen in Table 2, during the first two years, when hatching success was greatest, more renestings took place, and vice versa. The very low renesting rate of 7.7% in 1987 was probably due to a 279-mm rainfall in late May. Conversely, a severe drought gripped the area during this same period in 1988, which might have accounted for the low number of second nestings that year (U.S. Weather Service, Fort Sill, Oklahoma). In Missouri, Kridelbaugh (1983) found that 22% of birds he studied renested in 1980 and 1981. Fifteen (58%) of 24 second nestings in Oklahoma succeeded, a higher percentage than the 46% overall rate. Of the 10 second nests that failed, one was abandoned, another succumbed to predation, and eight failed for unknown reasons.

Second nest attempts may be related to length of growing season. More days of favorable weather, coupled with the fact that breeding begins very early here, afford ample opportunity for rearing two broods most years. Food is generally available for a longer period as well. As shown in this study, up to one-third of all shrike pairs may attempt second nests during normal years (Table 2), but the vagaries of weather often prevent it.

In cases where nests were found empty but intact, predation was strongly suspected. Known nest predators common to the area included housecats (*Felis domesticus*), various snakes, and grackles (*Quiscalus mexicanus* and *Q. quiscula*).

In this study, the probability of survival from the start of incubation until fledging for 109 nests was 46%. Except for Alabama (Siegel 1980), where it was 43.2%, this figure is low compared to other studies. For instance, it was 62.2% in Colorado, 69.1% in Missouri, and 72% in Illinois (Graber et al. 1973, Porter et al. 1975, Kridelbaugh 1983).

Local nesting habitat appears to be still relatively abundant, so explanations for the shrike's gradually failing numbers must be sought elsewhere. In this intensely agricultural region, insecticides are widely used,

but the relationship between them and declining shrike populations is difficult to establish. The continuing loss of native grasslands to plowing eliminates valuable shrike foraging habitat. Luukkonen (1987) found that 11 nests surrounded by pastures produced twice the number of young shrikes as did nests in other habitats. Even if these fields are reseeded in later years, it is seldom done with native grasses.

Inadvertent destruction of some nesting habitat (i.e., Osage orange hedgerows) is also occurring. Because of their durability, Osage orange posts were formerly widely used to support barbed wire fences. Over the years, and in widespread localities, these posts grew into tree rows. The prevailing current tendency, however, is to replace them with metal or creosote-treated posts, completely eliminating this valuable tree so often used for shrike nesting (Table 1).

The future outlook for survival of the Loggerhead Shrike in this part of its range is not good. With a mean survival rate of only 46%, the steady decline in its numbers is bound to continue if populations do not stabilize.

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