NEST SITE SELECTION AND REPRODUCTIVE SUCCESS OF SHRIKES

HABITAT OR CLIMATE? INFLUENCES OF ENVIRONMENTAL FACTORS ON THE BREEDING SUCCESS OF THE RED-BACKED SHRIKE (*Lanius collurio*)

Lorenzo Fornasari and Renato Massa

ABSTRACT

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To analyse climate effects on the population trend of Red-backed Shrike in Lombardy (northern Italy) we compared 1983-1993 temperature and rainfall patterns with changes in population size of a breeding cluster (10-20 pairs). In addition, we also related 1993-1995 climate data with population size, density and breeding success of a larger cluster (40-60 pairs) scattered through different habitat types.

In the long-term period, the population size was affected by overall June rainfall. Conversely, in the short-term period the breeding shrike density was positively affected by shrubland density together with hedge and fence length. Breeding success depended on different parameters, such as the area covered by woodlots and fen-meadows, as climate and predation effects were lower in these landscape patterns.

Breeding failure was mainly due to bad weather for nests in positions higher than 1 m (with some cases of corvid predation) and to mammal or reptile predation for nests closer to the ground.

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Key words: *Lanius collurio*, breeding success, habitat, climate, nest predation

INTRODUCTION

The Red-backed Shrike is considered as a species undergoing a global decreasing population trend (Heath 1994, Fornasari *et al*. 1997), despite some much-

localised increasing populations in northwestern Europe, as in Belgium (Gaume region – Van Nieuwenhuyse 1992) and in the Netherlands (Bargerveen reserve – Esselink *et al*. 1995). The decline has been most severe in northwestern Europe, where the species has been decreasing for over a century (Ash 1970).

Habitat and climate are both considered as factors affecting the breeding success and the distribution of the Red-backed Shrike. Several authors have variously stressed the role of climatic and habitat changes. Heat (1994) has pointed out that destruction and deterioration of habitat „are thought to be the major causes of the Red-backed Shrike's decline in Europe" (see also Jakober and Stauber 1981, 1987); the reduction of suitable habitat may be due to the increase of cultivated land, the intensification of farming and the afforestation (Jakober and Stauber 1987, Kowalski 1993). On the other hand, the increase of rain in late spring has been indicated as a reason for the extinction of the Red-backed Shrike in England (Bibby 1973) and for its rarity in France (Lefranc 1993) and in the Netherlands (Hustings and Bekhuis 1993), even if the loss „of prime farmland habitats is likely to have played an important role" in the noticeable decline over the western part of the species range (Hustings and Beckhuis 1993).

If several possible causes for the decline have been identified, it is still difficult to determine the relative importance of each (Van Nieuwenhuyse *et al*. 1999). Nevertheless, understanding how the different factors interact in determining Red-backed Shrike population trends is a key problem for an effective species-devoted conservation strategy. To evaluate how habitat and climate parameters influence the Red-backed Shrike density and breeding success in the southern part of its range, we analysed data from two different populations located in the centre of the Southern Alps, in Lombardy and surveyed during the 1980s and the 1990s.

STUDY AREA AND METHODS

We conducted field studies on the Red-backed Shrike in the Albonico Bird Observatory (ABO) and in the Pian di Spagna Nature Reserve (PSR) – two areas a few kilometres apart in the northern portion of Como province, at the northern shore of the Como Lake, in Lombardy, northern Italy. Red-backed Shrikes are present from early May until mid-August (Ricossa and Massa 1988). The ABO study area is in the small Albonico vecchio valley, extending over about 20 ha at an altitude of 600 m between Mt. Peschiera and Mt. Berlinghera. It is partly covered with chestnut and pinewoods, partly occupied by extensive pastures interrupted with bushes of hawthorn, blackberry, broom, heather and small birch trees. The second study area is on an alluvial plane northwest of the mouth of the river Adda, and dividing Como Lake from the smaller Mezzola Lake, at an altitude of about 200 m. The PSR is 15 km^2, mainly occupied by cultivated grassland scattered with poplar trees and edges of several kinds of bushes, and bordered by sedge marshes and reed-beds (Fig. 1).

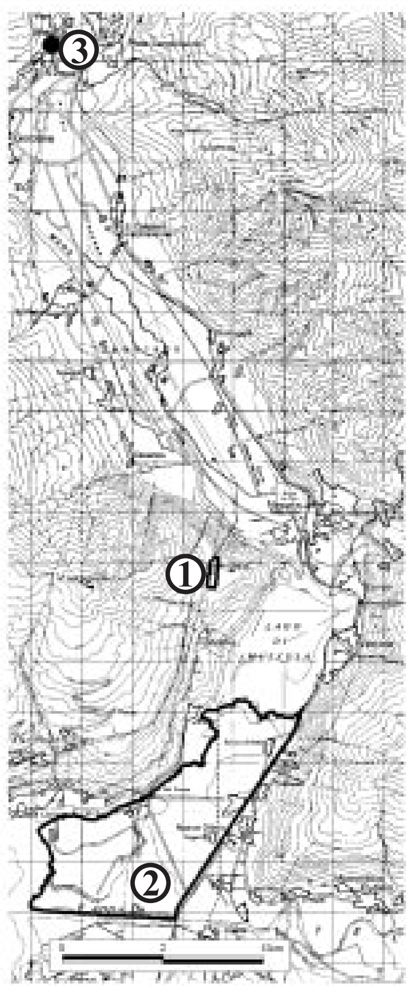

Fig. 1. Study areas: 1 – Albonico Bird Observatory; 2 – Pian di Spagna Nature Reserve; 3 – Mese Meteorological Station.

Population data were collected by means of extensive, annual bird censuses and bird ringing conducted through the whole breeding season (see Ricossa and Massa 1988, Fornasari *et al*. 1995), during 1984-1993 in the Albonico vecchio valley, and during 1993 and 1995 in the Pian di Spagna Nature Reserve.

Weather data (daily temperature and rainfall) for the survey period are from the Mese meteorological station, 19 km north of the study area. These data were gathered into resumptive variables by averaging minimum temperature, maximum temperature and rainfall over 15-16-day periods (starting from the second half of April to the first half of August), one-month periods (May, June, July), and a three-months period (May-July). On the same basis, the number of rainy days was assessed.

These parameters were related with the number of Red-backed Shrike pairs „breeding in the following year" in the Albonico vecchio valley and „successfully breeding in the same year" in the PSR.

In the PSR, the number of pairs attempting to breed and the number of pairs successfully breeding were independently assessed within 44 of 500-m squares. This estimate was separately performed with 1993, 1994, and 1995 data. Subsequently, the numbers of „attempting pairs" and „successful pairs" were statistically related to habitat characteristics by means of multiple (stepwise) regressions (see Manly 1994). After preparing a 1 : 5000 habitat map, we scored as „percentage of coverage" the following habitat categories: (1) meadows, (2) wet meadows, (3) mowed fields, (4) maize fields, (5) sedge marsh, (6) reed-beds, (7) woodlots, (8) shrubs (including fen-carr), (9) canals, (10) lake/river, (11) residential. Moreover, we estimated the length of the following linear habitat components: (a) trees hedgerows, (b) mixed trees/shrubs hedgerows, (c) shrubs hedgerows, (d) fences, (e) country roads, (f) roads and railways.

Finally, in the PSR we followed 61 nests until their success or failure, to identify fine scale effects of habitat and climate on breeding success.

POPULATION ESTIMATES

The cluster of Red-backed Shrikes breeding in the Albonico vecchio valley was stable during 1984-1990, varying between 10 and 13 pairs (starting from 1984: 10, 12, 12, 10, 10, 13, 10). A decline started in 1990 reaching four pairs in 1993 (starting from 1990: 10, 7, 6, 4). This decline was the main reason why we moved our study area to the nearby PSR, where we found a breeding population of about 70 pairs (starting from 1993: 71, 69, 71).

RESULTS

In Albonico valley, during the breeding season, the rainfall was very variable during 1983-1995, ranging from 320 mm to more than 1000 mm. In the ABO population, the number of pairs found appears negatively affected by the rainfall in the second half of June of the previous year (r = -0.657, p < 0.05, Table 1) and by the number of rainy days in the first half of June of the previous year (r = -0.491, p = 0.15; Table 1). As females in this area are normally incubating from late May until early June (Ricossa and Massa 1988), the rainfall affects the breeding success by its negative influence on fledglings. When nestlings are still small (first half of June) a lesser amount of rain is enough to cause failure, while nestlings close to fledging or just fledged (second half of June) are mainly affected by heavy rainfall. We did not find any significant negative effect of low temperatures in the same period (correlation between minimum average temperature and number of pairs: r = -0.05 in the first half of June, r = 0.37 in the second half of June).

Some similar indication comes from the PSR population, which showed its higher breeding success in 1994 (32 pairs out of 69 – 46.4%), when the overall June rainfall was low. Its lowest breeding success was in 1995 (27 pairs out of 71 – 38.0%), when the rainfall for the first half of June was almost twice that of 1994 (see also Table 2).

At PSR of the 61 nests we followed until their success or failure, nests of 1 m or more were more likely to be affected by inclement weather and three were destroyed by wind. When compared with nests above 1.5 m, nests built between 0.25 to 1.5 m, show a higher rate of success (28.3% *vs* 15.4%), even considering their higher predation rate (50.0% *vs* 7.7%). Bad weather (mainly rain) caused the abandonment of 21.7% of the „low" nests and 76.9% of the „high" nests.

Table 1
Meteorological parameters in year *x* related to the population size in year *x + 1* in the ABO area

Year *x*	Rainfall 2nd half of June	Rainy days 1st half of June	Year *x + 1*	Breeding pairs
1983	18.5	2	1984	10
1984	27.5	3	1985	12
1985	44.5	5	1986	12
1986	5.0	4	1987	10
1987	83.5	8	1988	10
1988	38.5	5	1989	13
1989	32.5	5	1990	10
1990	140.0	9	1991	7
1991	178.0	7	1992	6
1992	71.5	6	1993	4

Table 2
Meteorological parameters compared with the number of attempting and successful breeding pairs in the PSR area

Year	Rainfall 1st half of June	Rainfall 2nd half of June	Attempting pairs	Successful pairs
1993	60	79	71	30 (42.2%)
1994	41	7	69	32 (46.4%)
1995	75	8	71	27 (38.0%)

We cannot infer a precise estimate of predation by different predator species. We observed predation by Red Fox (*V. vulpes*), Aesculapian Snake (*Elaphe longissima*) and Whip Snake (*Coluber viridiflavus*); other potential predator species present in this area include Jay (*Garrulus glandarius*), Hooded Crow (*Corvus corone cornix*) and Stone Marten (*Martes foina*). Considering the plant species used for nesting (Fig. 3), predation is concentrated on the most frequently used shrub species (European Dewerry – *Rubus caesius,* Wayfaring-tree – *Viburnum lantana* and Black

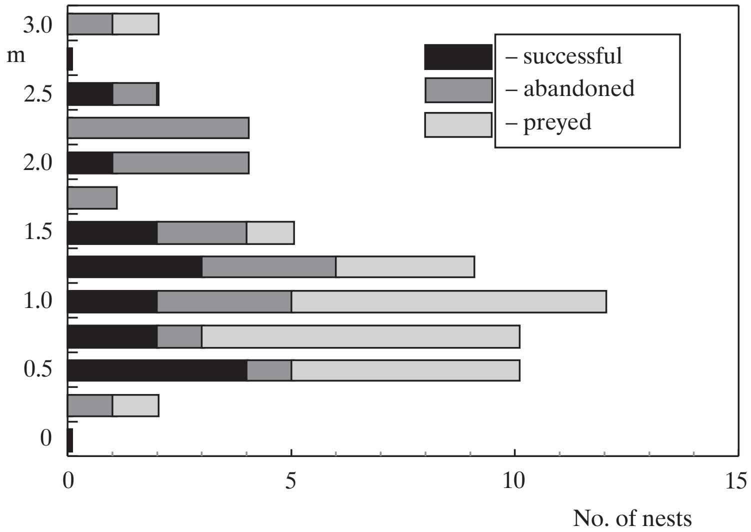

Fig. 2. Distribution of successful and unsuccessful nests according to the height of their location.

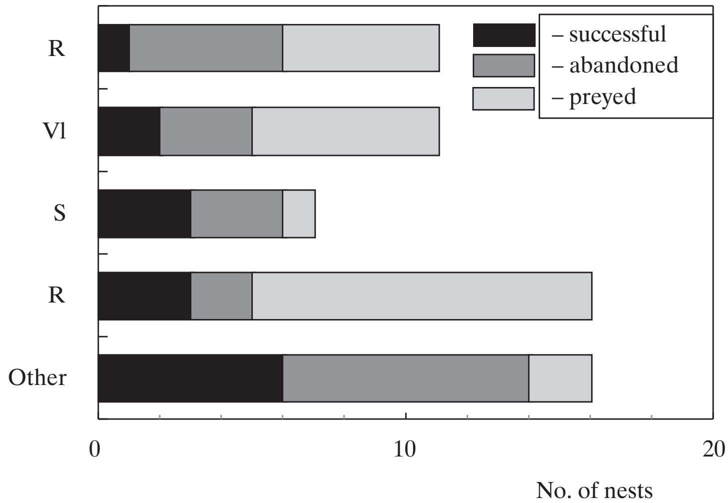

Fig. 3. Distribution of successful and unsuccessful nests according to the different plant species. Rp – *Robinia pseudoacacia*, Vl – *Viburnum lantana*, Sn – *Sambucus nigra*, Rc – *Rubus caesius*

Locust – *Robinia pseudoacacia* – the last seems particularly inefficient also against the bad weather). This could be possibly related to the use of „search images" by the predators, a well-known phenomenon among vertebrates (*e.g.* Krebs and Davies 1981). On the other hand, this observation suggests which of several shrub species

should be considered in case of landscape planning directed toward Red-backed Shrike conservation.

Shrubs availability is one of the main factors influencing the distribution of the breeding pairs. In fact, according to the stepwise regression analysis (Table 3), it appears that the distribution of the PSR „attempting" pairs depends on the potential nesting places (length of hedges of trees and shrubs, and area occupied by shrubs) and perching sites (fences length). On the other hand, the distribution of the „successful" pairs appears partly related to different parameters. First, the availability of nest sites is still important, but small woodlots appear far safer than linear tree hedges, even if they are not a factor associated with general habitat selection (this parameter is not included in the model for the attempting pairs, which is the number of pairs present in a square increase according to the variation of other parameters). Second, natural wet meadows (wetland area) are fundamental as feeding grounds: the distribution of all the pairs (attempting pairs) is unrelated with any of the „feeding ground" categories, as some kind of grassland is everywhere available in this area. However, the distribution of the successful pairs depends on this only habitat category out of at least four potential feeding habitats (categories 1 to 4). This relation became evident in the two years with a lower breeding success (42.2% and 38.0% in 1993 and 1995, respectively, *vs* 46.4% in 1994), indicating a possible interaction between habitat characteristics and weather pattern in influencing the breeding success.

Table 3
Habitat parameters significantly related with the number of attempting and successful breeding pairs in the PSR area

Habitat parameters	Attempting pairs			Successful pairs		
	1993	1994	1995	1993	1994	1995
Tree hedges length		**				
Tree/shrub hedges length	**	**	**	**	**	**
Shrub area	**		**		**	
Fences length	*	**	**			
Woodlots area				**		**
Wetland area				**		**
Multiple *R*	0.73	0.72	0.73	0.76	0.67	0.67

* - statistically significant ($p < 0.05$), ** - highly statistically significant ($p < 0.01$)

DISCUSSION

Regarding Red-backed Shrike population trends, Heath (1994) summarised that „there is a widespread and continuous decline in range and numbers in Europe, probably due mainly to loss and deterioration of habitat, and (in north-western Europe) climatic changes". We would like to stress the possible interaction between habitat and climate on the breeding success of the Red-backed Shrike.

What is believed to be the optimal Red-backed Shrike habitat has been described several times. Van Nieuwenhuyse (1996) summarises that this species needs: (1) some elevated perches to easily look for terrestrial prey; (2) open, rough ground with low grassland vegetation for hunting (Yosef and Grubb 1993) together with tall grasses to increase insect availability as preys (Bakker *et al.* 1989); (3) (thorny) bushes for nesting (Van Nieuwenhuyse and Vandekerkhove 1992). We discuss these three aspects according to our findings.

Considering Table 3, it seems that the Red-backed Shrike density increases with the abundance of hunting perches (fences length and hedges length). But we may argue that this is not related with habitat quality, if we assume that habitat quality for a bird species can be estimated from its breeding success. This consideration drive us to the paradoxical result that habitat quality seems to be not sufficiently perceived by the Red-backed Shrike at the level of site selection (at least in rainy breeding seasons), or, in other words, that the influence of natural grassland habitats on the breeding success is, on average, underestimated by the breeding pairs. Therefore, we recommend that any habitat management plan for Red-backed Shrikes and probably other shrikes, schould be comprehensive, and not concentrate on one easily completed step – addition of perches (as described by Van Nieuwenhuyse 1996).

Regarding food availability, some papers (Esselink *et al*. 1995, Hornman *et al*. 1998) describe how natural habitats such as peat-moors allow prey availability during the entire nesting period, while this cannot be certain for agricultural meadows. As several agricultural practices (land draining, intensive manuring, pesticide use) may change invertebrates' abundance and richness, mainly affecting large insect species (Siepel 1990), the occurrence of bottlenecks in prey availability is more probable in simplified farmland habitats than in diverse natural meadows. Beside other temporal effects, Red-backed Shrike diet composition is in fact influenced by habitat type and, what is important to our point of view, weather conditions, as shown by Hornman *et al*. (1998). These authors found that the activity of the prey taxa was decreased by rain, low temperature, and strong wind, requiring more hunting activity and affecting nestling growth and survivorship through a longer exposition to bad weather. It is likely that such a critical situation arises more frequently in artificial farmland habitats than in natural grassland habitats. There is no doubt that rainy weather negatively affects Red-backed Shrike persistence (see ABO population data), influencing the breeding success (see PRS population data). Data in Table 3 underline that breeding success was lower in years affected by bad weather mainly due to an increase of failures within squares not or poorly provided with wet meadows. Consequently, we think that when planning habitat restoration the insect supply might be taken into account. Our results and Esselink's (1995) statement point out that restoration of isolated wetlands, at least in some cases, may be a useful tool in the shrike habitat management.

Regarding the nesting sites, our data on the PSR population (Fig. 3) suggest that thorny bushes are not always the best, even if they are used more frequently than

other plant species – nests built on Brambles *Rubus caesius* were successful only in 3 cases out of 16, failing especially due to predation. On the contrary, increasing nesting success appears to depend on a wider diversity of stands. Looking at our data of Table 3, it seems that the Red-backed Shrike positively selects, but perhaps not enough, for areas with sure nest sites – woodlots or shrub area was important to determine the breeding success in different years, while for example the tree hedges length, when selected (1994) was not a good choice. Nest predation can be the main factor responsible for breeding failure and population decline (see Diehl 1995). Reducing predation rate through habitat diversification in populations under climatic stress could also be considered. Moreover, small trees (up to 6 m high) carrying nests in high position (up to 3 m) suffer comparatively more from adverse weather (see Fig. 2). To reduce predation pressure on the low nests by improving the shrub density and distribution could also result in an increase of occupation of a climatic-safer height.

In summary, we recommend that conservation actions should consider the effect of bad weather conditions, by:

1. Preserving fences and perching sites to regulate the breeding density according to the carrying capacity of the landscape type.
2. Improving the diversity and vigour of invertebrate communities.
3. Improving the diversity and quality of shrubs available for nesting.

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