AVES 36 (1-3) 1999 : 179 - 192

The ecology and conservation of the Red-backed Shrike *Lanius collurio* breeding in Europe

In remembrance of my dear father Livinus Van Nieuwenhuyse 21.06.1921 – 20.06.1998

by Dries VAN NIEUWENHUYSE[1], Friedel NOLLET[2] & Andy EVANS[3]

Red-backed shrikes Lanius collurio are in widespread decline across much of their range in north-west Europe. A review of the ecology of this bird suggests that populations of the large insects preyed upon by red-backed shrikes have declined as a result of habitat destruction and degradation due to changes in farming practice. Availability of nest-sites may also have decreased as a result of marginal land being increasingly brought into agricultural production. Management techniques which could improve habitat quality are suggested. However, the future of this species is probably dependent on a return to more extensive agricultural techniques and this will involve fundamental changes in international policies.
Key Words : red-backed shrike, Lanius collurio, *conservation, agriculture, diet.*

INTRODUCTION

Red-backed shrike populations are in widespread decline across much of the species' European range and many of these declines have been occurring for several decades (Table 1). A recent review indicated that the bird had declined in 10 out of 11 EC countries for which there are data (TUCKER *et al.*, 1994; Table 1). No confirmed breeding was reported in Britain for the first time in 1989, although occasional pairs have bred since (SPENCER *et al,* 1993). Only in Finland is the population thought to be increasing (Table 1).

Possible reasons which have been suggested for the widespread decline include climatic changes, loss of habitat or a deterioration in habitat quality, poisoning through the direct effects of pesticides and increased adult mortality through hunting. Here we review the ecology of red-backed shrikes to try and determine the relative importance of each of these possibilities. We also present suggestions for conservation actions at the

(1) "Het Speihuis", Speistraat 17, B - 9550 Herzele.
(2) Bellemdorpweg 74 A, B - 9881 Aalter.
(3) The Royal Society for the Protection of Birds. The Lodge, Sandy, Bedfordshire SG19 2DL, UK.

Table 1 - *Population levels and trends of Red-backed Shrike in EC countries. - Niveaux de population et tendances chez la Pie-grièche écorcheur en Europe.*

Country	Population Level	Trend[1]
Spain		- 20-50%
Portugal		- 20-50%
Italy		- 20-50%
Greece		- 20-50%
France		- 50-100%
Britain	Common until 1930[2], 253 pairs in 1963, 81 in 1973[3]. No confirmed breeding in 1989[4].	- 50-100%
Germany	Decline in north & north-west. One population fell from 57 to 5 pairs between 1948 & 1973[5] Another fell by 50% between 1976 & 1979[6].	- 20-50%
Belgium	5.000 pairs 1930 to 570 in 1970s[7] Recently stable or increasing in south[8].	stable
Luxembourg		- 20-50%
Netherlands	Only 80-140 pairs left in 1985[7].	- 20-50%
Switzerland	Severe decline in central plain[9].	
Denmark	Maximum of 3.000 pairs in 1974, marked decline[10].	
Ireland		unknown
Czechoslovakia	Large decline after 1960[7].	
Rumania	Decrease since 1980 probably declining for much of 20th C.[7]	
Estonia	Rapid decline in 1970s[7].	
Latvia	Recent increase in peat bogs[7].	
Finland	50.000-100.000 pairs[7]. In 1936-49 population estimated to be only 15% of 1973 level[11].	

1. TUCKER *et al* (1994); 2. PEAKALL (1962); 3. BIBBY (1973); 4. SPENCER (1993); 5. POLTZ (1975); 6. JAKOBER & STAUBER (1987b); 7. CRAMP & PERRINS (1993); 8. VAN NIEUWENHUYSE & VANDEKERKHOVE (1989); 9. SCHIFERLI & BIBER (1987); 10. DURANGO (1950); 11. JARVINEN & VAISANEN (1978).

local scale. Three congeneric species (Great Grey Shrike *L. excubitor;* Lesser Grey Shrike *L. minor* and Woodchat Shrike *L. senator*) are in severe decline in north-west Europe (TUCKER *et al.*,1994) and the North American population of loggerhead shrikes *L. ludovicianus* is also decreasing rapidly (SMITH & KRUSE, 1992).

Populations of many species of passerine have been tumbling on farmland since the mid 1970s, both in Britain (FULLER *et al.*, 1995) and in the rest of Europe (TUCKER *et al.*, 1994). This discussion is, therefore, of more general interest.

Ecology of Red-backed Shrike

Habitat selection

Red-backed shrikes occupy a wide range of habitats (CRAMP & PERRINS, 1993) usually comprising open, rough ground interspersed with patches of dense scrub. Agriculturally unimproved and semi-natural pastures, disused meadows with scrub, orchards and hay-lands surrounded by hedges are all used (JAKOBER & STAUBER, 1987a). Less commonly occupied habitats across Europe include lowland heathland (ASH, 1970) and forest clearfells or young plantations (CHRISTEN, 1983; KUSSMAUL, 1987).

Diet

The main component of the diet is large insects, especially Coleoptera and Orthoptera (CSIKI, 1904; KORODI GAL, 1969; MANN, 1983; CRAMP & PERRINS, 1993). Lizards, small mammals and birds are occasionally taken (KOWALSKI, 1984; ASH, 1970). Prey choice varies seasonally with availability. For instance, in one study, the percentage of Coleoptera in the diet decreased from May to August while the proportion of Hymenoptera increased (WAGNER, 1993). In another study birds switched from bumble bees and scarab beetles in early summer to grasshoppers after July (JAKOBER & STAUBER, 1987a). The red-backed shrike is opportunistic; voles *Microtus arvalis* and mice are commonly taken in years when their populations peak (JAKOBER & STAUBER, 1987a; MANSFELD, 1958). Cockchafers *Melolontha melolontha* are preferred when abundant and can comprise up to 64% of prey items in some years (MANSFELD, 1958). Temporal abundances of *Ocypus olens* (Staphylinidae) were exploited in Belgian Lorraine (Van Nieuwenhuyse, pers obs). Amphibia are taken in poor insect years (MIELEWCZYK, 1967). Smaller prey (e.g. ants) are only caught when appearing in large numbers (WAGNER, 1993).

Hunting techniques

Shrikes use two visual hunting techniques; 'perch and pounce' which involves dropping from a perch on to the ground and aerial catches, again normally from a perch. Which technique is used depends on the prey accessibility and vegetation structure. Aerial catches predominate when vegetation is high but on short vegetation (or an interface between high and short) terrestrial catches are preferred (Van Nieuwenhuyse, pers obs). Loggerhead shrikes showed a similar change in foraging behaviour and a change in diet after vegetation was cut (YOSEF & GRUBB, 1993). When prey is abundant both species prefer to make terrestrial catches (VAN NIEUWENHUYSE *et al.* 1993; YOSEF & GRUBB, 1993). Shrikes therefore, need an area of species-rich grassland of varying length to provide a high density and diversity of insect prey and sufficient hunting opportunities.

Many shrikes, including red-backed, cache prey by impaling items on thorns or snags, often forming 'larders' (OWEN, 1948). Such caches are thought to be used when prey is hard to find (*e.g.* during rain) or when the energetic demands of chicks are high (*e.g.* in the morning) (DURANGO, 1951; BEVEN & EENGLAND, 1969; MANN & BRANDL, 1986; HERNÀNDEZ, 1995).

Nesting sites

Small, dense thorny shrubs are preferred (JAKOBER & STAUBER, 1987a; LEFRANC, 1993). In Belgium the species breeds mainly in rose *Rosa* sp, hawthorn *Crataegus sp*, blackthorn *Prunus spinosa* and bramble *Rubus* sp. (Van Nieuwenhuyse, *pers obs*; VAN WINKEL, 1967). Isolated shrubs are preferred to linear hedges (VAN NIEUWENHUYSE & VANDEKERKHOVE, 1992). Most nests are between 0.4 and 1.8 m off the ground although some are as high as 25 m (LEFRANC, 1993).

Site fidelity

Red-backed shrikes tend to breed in small, loose groups (ASH, 1970; BIBBY, 1973; VAN NIEUWENHUYSE, 1992). It is thought that this behaviour may increase the chances of a male attracting a mate (Van Nieuwenhuyse, unpubl. data). They are also highly site faithful (VAN NIEUWENHUYSE & VANDEKERKHOVE, 1992; KWAK & STRONKS, 1993; JAKOBER & STAUBER, 1987a; MASSA *et al*, 1993). Males show higher fidelity to territories established in preceding years than females (JAKOBER & STAUBER, 1987b; MASSA *et al*, 1993). The degree of fidelity depends on the breeding success the preceding year (JAKOBER & STAUBER, 1978). After a breeding failure some females abandon their partners. Only 6% of young birds return to their natal area to breed, the majority of first-year birds settle elsewhere.

Possible causes of the decline

Climatic change

Two theories for the decline involve climatic change :

It has been suggested that a deterioration in the climate took place across much of the breeding range (DURANGO, 1950; MÜNSTER, 1958; PEAKALL, 1962; BIBBY, 1973; HÖLZINGER, 1987). It has been shown that prolonged cold weather or rainfall during the nestling period can severely reduce breeding success (STAUBER & ÜLLRICH, 1970; KOWALSKI, 1984; MANN & BRANDL, 1986). This constitutes, therefore, an obvious mechanism whereby climatic change could lead to population decline. However, the degree or direction of any change in climate has not yet been fully established.

Habitat loss or change

For a long time theories of habitat loss or change were given little support. This may have been due to the wide range of habitat types used, or the fact that in many

abandoned areas the habitat remained apparently unchanged. However, most pairs in north west Europe occupy pastural farmland and there have been radical changes in farming practice over the last 50 years which have resulted both in a loss and a reduction in quality of this habitat (CHRISTEN, 1985; ELLENBERG, 1986; HÖLZINGER, 1987; JAKOBER & STAUBER, 1987a; KOWALSKI, 1987a & b; MARÉCHAL, 1993; VANDEKERKHOVE, 1993). Indeed the Red-backed Shrike is becoming recognised in some areas as a sensitive indicator of unimproved grassland (D. Pain *pers. comm.*). The species is often restricted to steep-sided valleys which have been protected from intensive agriculture by their topography (JAKOBER & STAUBER, 1987a; VAN NIEUWENHUYSE & VANDEKERKHOVE 1992).

Application of inorganic nitrogen as fertiliser to old pasture has lead to a reduction in the number of grass species and to earlier, denser and higher growth. Such changes lead to a decrease in the number of species and density of large insects *e.g.* Orthoptera (Morris, 1978; VAN WINGERDEN *et al.*, 1992). Associated changes in grassland management including increased stocking densities and earlier cutting (*e.g.* the switch from hay to silage) have further reduced prey availability (ELLENBERG, 1986; MARÉCHAL, 1993; VAN WINGERDEN *et al.*, 1991).

Increasing losses of marginal land to intensive arable production have reduced both insect-rich 'oases' and scrub for nest sites. Widespread use of insecticides may also have reduced prey availability. Food caches were common in Britain in the early 20th Century (OWEN, 1948) but unusual by the 1960s (ASH, 1970). This may be circumstantial evidence of a decline in insect prey.

Removal of hedgerows and isolated shrubs in order to enlarge fields for efficient operation of machinery has been widespread. Hedges have also become impoverished through inappropriate management such as mechanical flailing or indeed lack of management. In the UK 10% of all hedgerow length was lost between 1978 and 1990 whilst a further 13% became so impoverished that it was no longer classified as hedgerow (DOE, 1993).

In Finland the increase in population may be associated with changes in forest management, for instance an increase in clearfells, the birds' main habitat in this country.

Toxic effects of pesticides

Given their diet, it might be expected that red-backed shrikes would be vulnerable to toxic pesticides, in particular that they might accumulate damaging levels of organochlorines in their tissues. In the 1960s when DDT use was widespread in the UK, ASH (1970) found no evidence of a widespread problem with hatching success, although six unhatched eggs in 1962 were found to contain 'small amounts' of dieldrin, DDE and DDT. The current effects of DDT (both through direct toxicity and reduction of prey availability) on the wintering grounds in southern Africa are not known.

Hunting on migration

Red-backed shrikes are among many species of bird shot or trapped on migration in Mediterranean countries, North Africa and the Middle East (LEFRANC, 1993). Unfortunately there is little precise data concerning the number of individuals killed.

Conservation measures

The speed and extent of the decline of red-backed shrike populations in north-west Europe indicate that urgent conservation measures are needed. The evidence suggests that a number of factors may have contributed to the decline. Whilst there is insufficient data to identify the relative importance of each factor, it is not necessary to identify the primary cause of a species decline nor necessarily to address it in order to develop an effective conservation plan (GREEN, 1995). Changes in the extent and quality of the preferred habitat have been extreme and will almost certainly have contributed to the decline. If these changes can be arrested or reversed the conservation status of the red-backed shrike would be significantly improved.

Short term or emergency actions are suggested to save small or isolated populations. These actions are designed to improve habitat at the level of at leat several population clusters. Long term conservation measures to improve habitat on a wide scale depend upon revision of international policies that determine farming practice.

Additional information on this topic was published by JAKOBER & STAUBER (1987c) on *Lanius collurio* and SCHÖN (1994) on *Lanius excubitor* and in general.

Habitat management at the local level

Large insect prey is typically found in abundance near agriculturally unimproved, species-rich grassland. Tall vegetation is an important source of food for some insects and in some species provides oviposition sites. Other species require bare ground for oviposition. Creating a high diversity of insect prey is thus best achieved by providing a diverse habitat (MORRIS, 1978). Figure 1 shows a schematic example of rotational grassland management designed to achieve a mosaic of vegetation length. Mowing meadows in stages or zones should improve the ratio of accessible to available prey. Grazing is another way to achieve a variety of vegetation length, although stocking density is critical. A low stocking density will result in patches of tall vegetation (BAKKER *et al.*, 1989; BAKKER & BAKKER, 1989; HULZINK, 1989; VAN DER BILT, 1989) and have beneficial effects on the number of species and density of orthoptera (VAN WINGERDEN *et al.*, 1991). For *Metrioptera roeselii, M. bicolor, Chrysocraon dispar* and especially for *Omocestus viridulus* unmown refuges need to cover at least one third of the surface (JACOB, 1989). Smaller parcels of land should be managed to include the maintenance of some stretches of unmown vegetation, rotated every 2 to 5 years (DECLEER, 1989). DECLEER suggests 20% of the total surface area of vegetation should be left tall to maximise insect

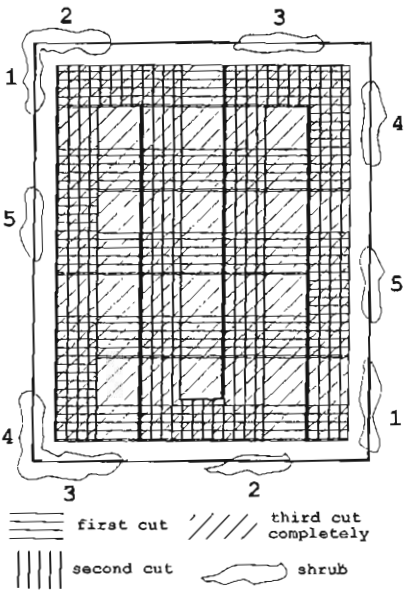

Fig. 1 - *Example of a beneficial management option for an extensively grazed meadow. The different zones are mown at different times in the season. Hedges are managed cyclically over a number of years, with different hedges trimmed each year. Numbers indicate the year of trimming. - Exemple de plan de gestion d'une prairie extensive. Les différentes zones sont fauchées à différents moments dans la saison. Les haies sont taillées selon un cycle de plusieurs années, avec des portions différentes taillées chaque année. Les chiffres indiquent les années de taille.*

populations. For red-backed shrikes a zone of 2-3 m at both sides of the fences should be left as high vegetation within territories.

Hedges and woody shrubs are also important for insects (PFISTER & NAEF-DAENZER, 1987; ZWÖLFER *et al* 1984). Specific small-scale habitats for invertebrates can easily be created, e.g. piles of dead wood, tree stumps, rotting bales of hay, carrion (MORRIS, 1978).

It may be possible in extremely isolated territories or small populations (such as exist in Britain) to increase the chances of successful breeding by supplying food artificially, particularly in periods of adverse weather. Artificially provided mealworms *Tenebrio molitor* are not only accepted by red-backed shrikes but can become the main exploited food source (CARLSON, 1989).

Improving prey accessibility

The preferred "perch and pounce" hunting method is ineffective in high vegetation. Shrikes prefer to hunt at the interface of high and short vegetation; after mowing the highest densities of prey occur in the high vegetation (JACOB,1989; Van Nieuwenhuyse pers. obs.) but individual items only become detectable and thus accessible when they cross the interface (LEFRANC, 1993; JAKOBER & STAUBER, 1987a). The quality of a territory is probably determined by the ratio of high to short vegetation and the distribution of patches (VAN NIEUWENHUYSE & VANDEKERKHOVE, 1992). Unmown patches are also of crucial importance for the survival and recolonisation of grasshopper populations after mowing (JACOB, 1989). SCHÖN (1994) illustrates the importance of similar

micro-structures and edge-effects in the ecology of the Great Grey Shrike *Lanius excubitor*. Ways of ensuring a mosaic of vegetation length have already been described.

Perches are essential for the hunting techniques used by shrikes. Shrubs, fence posts, barbed wire, electrical wires, rocks, buildings, trees, dead branches, bales of hay, thistles, flowering Umbelliferae, and piles of wood are all used. The addition of artificial perches (100 to 200 cm high) to a territory increases the accessible hunting area (Fig. 2). Poles placed in a 12.5 m grid were preferred by a foraging male over the shrubs normally used as perches (VAN NIEUWENHUYSE *et al.*, 1993). Experiments on great grey shrikes showed that provision of additional perches caused individuals to compress their active range and forage more efficiently (YOSEF, 1993). Permanent perches could be provided by shrubs planted in a grid of 12 to 20 m (VAN NIEUWENHUYSE *et al.*, 1993; MOES, 1993). In the Great Grey Shrike a similar optimisation is suggested (SCHÖNN, 1994) but at larger intervals (30-100 m, max. 200 m). Tall perches are often used during mate-guarding and tending of the fledglings (Van Nieuwenhuyse, pers. obs). Such perches (250 to 500 cm) could also be provided artificially. Both SCHÖN (1994) and ROTHHAUPT & KLEIN(1998) researched the usable area as a key factor for habitat occupancy in the great grey shrike *Lanius excubitor*, SCHÄFER *et al.* 1996 in the red-backed shrike *Lanius collurio*.

Increasing nesting opportunities

Although a variety of sites are used, nests are most commonly found in scrubby or thorny bushes. Suitable shrubs can be planted in potential or existing territories, either in isolation or in linear hedges. Between 1% and 4% of the total surface should be covered with shrubs (LEFRANC, 1993). SCHÄFER *et al.* (1996) researched 15 territories and found 50-250 unclustered structural elements (shrubs, poles etc.) per ha. with at least 88% of the territory free of shrubs. Management is important to achieve and maintain the correct structure and density; this can be achieved by trimming or grazing. Trimming and burning of brash should obviously be avoided during the breeding season (May to August).

Shrikes have recolonised areas when artificial nest sites have been created by placing trimmed branches of thorny shrubs in piles (DURANGO, 1950). Benjes hedges (BENJES, 1992) are composed of linear piles of cut branches and give results very fast (Van Nieuwenhuyse, pers. obs.; SUTOR, 1995).

Creation of a potential territory

Potential new territory units can be created by targeting small parcels of land ('islands' of c. 10 m by 30 m) to include all the requirements described above (Fig. 3). Habitat improvement is most likely to be successful if carried out on a scale sufficient to support several pairs; we suggest between 6 and 12 units per Ha would be appropriate as it would mimic natural densities. Islands should be created with a variety of orientations. In Germany, restoration of stone mounds (Steinriegel) in agricultural fields create similar islands containing all the parameters (SCHÖN, 1998).

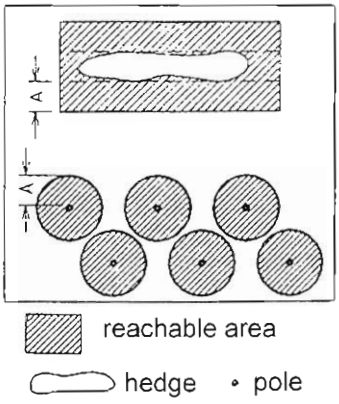

Fig. 2 - *The area accessible to a hunting red-backed shrike can be considerably increased by providing artificial perches. If 'A' (the normal hunting flight distance for a terrestrial catch) = 3 m, then the total area accessible from an 18 m hedge in this example is approx. 110 m² whilst from the six perches an additional area of 170 m² is accessible. - La surface accessible à une Pie-grièche écorcheur chassant peut être considérablement augmentée en lui fournissant des perchoirs artificiels. Si 'A' (la distance normale de vol lors d'une chasse au sol) = 3 m, la surface totale accessible à partir d'une haie de 18 m, dans cet exemple, est d'environ 110 m² tandis qu'à partir des 6 piquets, une surface supplémentaire de 170 m² est accessible.*

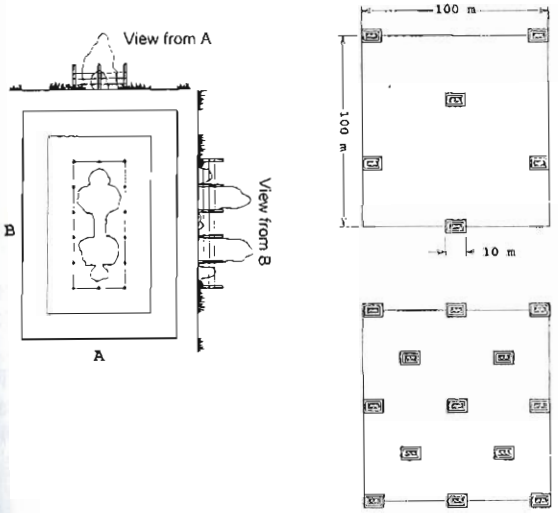

Fig. 3 - *Suggested construction of territory units or artificial "islands". Each island measures c. 10 x 30 m and is composed of a suitable variety of shrubs, dead branches, a fence and is surrounded by an unfertilized zone of 10 m with the outer 5 m mown. - Suggestion d'aménagement d'un territoire ou "île" artificielle. Chaque îlot mesure environ 10 x 30 m et est composé de diverses variétés de buissons, branches mortes et d'une clôture et est entouré d'une zone non fertilisée de 10 m dont les 5 m extérieurs fauchés.*

Actions at the National and International scale

The survival of the red-backed shrike across much of north-west Europe is probably dependant on the continuation of low intensity agricultural practice in sufficient areas. Initiatives should be taken to promote less intensive agricultural techniques and reduce both the nutrient input in farmland and the grazing pressure. Silage production should be discouraged in favour of hay. Scrub and hedgerow removal needs to be slowed or reversed.

Historically the Common Agricultural Policy (CAP) has favoured intensification through price support schemes. However, the introduction of the agri-environment regulation in May 1992 now allows for extensification, including aid for organic farming, environmentally sensitive farming and habitat creation through long-term set-aside. All

these schemes have the potential to preserve or recreate shrike habitat. At the moment, however, joining to these schemes is voluntary and frequently the financial incentives aren't sufficiently large. Moreover there is a lack of flexibility in the schemes which hampers implication of prescriptive measures for specific species. Further reforms to CAP should be sought to remedy these points.

Co-ordination of international actions will be crucial. For instance it is probably unlikely that conservation initiatives will succeed in the UK until the populations in northern France, coastal Belgium and Holland build up.

CONCLUSIONS

The scale and speed of the decline in breeding range and numbers of red-backed shrikes is giving cause for concern. Several possible causes for the decline have been identified. Although it is not possible to determine the relative importance of each, conservation of habitat appears to be an important issue. There are examples where local populations have increased after positive habitat management. In the Netherlands a local population on a peat moor grew from 12 pairs in 1987 to 104 in 1992 (VAN BERKEL, 1993; ESSELINK *et al.*, 1993). During this period peat extraction ceased and a low intensity grazing regime designed to produce a mosaic of vegetation with many transition zones was introduced. A local population in Germany increased from 11 pairs in 1984 to 33 in 1990 following planting of shrubs (RATZKE & SCHRECK, 1992). These examples suggest that this species might be able to respond quickly if conservation measures were successful in improving the quality of available habitat on a wide scale.

ACKNOWLEDGEMENTS - The authors wish to thank Kris Decleer for his co-operation in documenting the entomological elements. Martin Schön, Debbie Pain, Lennox Campbell, Ian Fisher and Mark Avery made useful comments on the manuscript. We would particularly like to thank Dr Brian Davis for his many constructive comments.

RESUMÉ - Ecologie et protection de la Pie-grièche écorcheur (*Lanius collurio*) en Europe.

Les effectifs de Pies-grièches écorcheurs sont en très grande diminution dans la plupart de leurs habitats du nord-ouest de l'Europe. Un examen de l'écologie de cet oiseau suggère que le nombre des grands insectes, proies de la Pie-grièche écorcheur, a diminué suite aux destructions de leurs habitats et aux changements des pratiques agricoles. La disparition des terres marginales et des lisières au profit de terres agricoles entraîne la disparition des sites de nidification. La rapidité de cette évolution nécessite d'urgence la prise de mesures de protection. Les zones d'habitat privilégiées par l'espèce ont considérablement changé suite aux nouvelles méthodes d'exploitation tant agricoles que forestières. Un retour à des méthodes plus traditionnelles permettrait d'améliorer sensiblement la protection de la Pie-grièche écorcheur. Cela permettrait en outre une présence accrue des proies préférées de la Pie-grièche écorcheur : il y a des exemples qui en témoignent en Hollande et en

Allemagne. Des techniques de gestion sont proposées pour améliorer la qualité de l'habitat de l'espèce. Toutefois son avenir est probablement tributaire d'un retour à des techniques agricoles plus extensives et ceci implique de profonds changements dans les règlements internationaux.

REFERENCES

ASH, J. (1970) : Observations on a decreasing population of Red-backed Shrikes. *Brit. Birds*, 63 : 185 - 205; 225 - 239.

BAKKER, J.P., DE LEEUW, J. & VAN WIEREN, S.E. (1989) : Micro patterns in grassland vegetation created and sustained by sheep grazing. *Vegetation*, 55 : 153 - 161.

BAKKER, D.L. & BAKKER, J.P. (1989) : Het Westerholt. IX: veranderingen in vegetatiesamenstelling en -patronen na 15 jaar beweiden. *De Levende Natuur*, 90 : 114 - 119.

BENJES, H. (1992) : *Die Vernetzung von Lebensräumen mit Feldhecken.* Natur & Umwelt-Praxis. Band I.

BEVAN, G. & ENGLAND, M.D. (1969) : The impaling of prey by Shrikes. *British Birds*, 62 : 192-197.

BIBBY, C. (1973) : The Red-backed Shrike: a vanishing British species. *Bird Study*, 20 : 103 - 110.

CHRISTEN, W. (1983). Besiedlung von Jungwaldflächen durch Neuntöter und Goldammer. *Orn. Beob.*, 80 : 133 - 138.

CHRISTEN, W. (1985) : Bestandsrückgang der Würger in der Aareebene westlich von Soloturn. *Orn.Beob.*, 82 : 125 - 127.

CRAMP, S. & PERRINS, C.M. (1993) : *Handbook of the birds of Europe, the Middle East and North Africa. The birds of the Western Palearctic. Volume VII Flycatchers to Shrikes.* New York Oxford University Press.

CSIKI, E. (1904) : Die Nahrung des Dorndrehers (*Lanius collurio* L.). *Aquila*, 11 : 280 - 288.

DECLEER, K. (1989) : Opportunities for invertebrates in nature management. *Verhandelingen Symposium "Invertebraten van België"*, 447 - 453.

DEPARTMENT OF THE ENVIRONMENT (1993) : *Countryside survey 1990 series. Volume 2: Main Report.* D.O.E., London.

DURANGO, S. (1950) : Om klimatets inverkan pa törnskatans *Lanius collurio* L. utbredning och levnadsmöjligheter. (The influence of climate on distribution and breeding success of the Red-backed Shrike.) *Fauna och Flora*, 45 : 49 - 78.

DURANGO, S. (1951) : Om törnskatans *Lanius collurio* L. spetsing ar bytesdjur. *Vär Fägelvärd*, 10 : 49 - 65.

ELLENBERG, H. (1986) : Warum gehen Neuntötern (*Lanius collurio*) in Mitteleuropa im Bestand zuruck ? Überlegungen zu den Auswirkungen von pestiziden sowie zu den Landschaftsveränderungen im Winterquartier und im Brutgebiet. *Corax*, 12 : 34 - 46

ESSELINK, H., GEERTSMA, M., KUPER, J., HUSTINGS, F., & VAN BERKEL, H. (1993) : Can peat-moor regeneration rescue the Red-backed Shrike (*Lanius collurio*) in the Netherlands? *In* YOSEF, R. & LOHRER F.E. (ed.) : Shrikes (*Laniidae*) of the world : biology and conservation. *Proc. West Found. Vert. Zool.*, 6 : 287 - 292.

FULLER, R.J., GREGORY, R.D., GIBBONS, D.W., MARCHANT, J.H.,WILSON, J.D., BAILLIE, S.R. & CARTER, N. (1995) : Population declines and range contractions among lowland farmland birds in Britain. *Conservation Biology*, 9 : 1425 - 1442.

GREEN, R.E. (1995) : Diagnosing causes of bird population declines. *Ibis*, 137 : 547 - 555.

HERNÀNDEZ, A. (1995) : Temporal-spatial patterns of food caching in two sympatric Shrike species. *Condor*, 97 : 1002 - 1010.

HÖLZINGER, J. (1987) : Einführung zum Artenschutzsymposium Neuntöter. *Beih. Veröff. Naturschutz Landschaftspflege Bad.-Württ.*, 48 : 7 - 16

HULZINK, P. (1989) : Pionieren met pony's in de Zepeduinen. *De Levende Natuur*, 90 : 119 - 124.

JACOB, J.-P. (1989) : Fauche, pâturage, orthoptères : premières observations sur les herbages de Lorraine belge. *Actes du Colloque "Gérer la Nature?"*, Anseremme 17-20 octobre 1989 : 807 - 810.

JAKOBER, H. & STAUBER, W. (1978) : Beerennahrung beim Neuntöter (*Lanius collurio*). *Vogelwarte*, 29 : 280.

JAKOBER, H. & STAUBER, W. (1987a) : Habitatsansprüche des Neuntöters (*Lanius collurio*) und Maßnahmen für seinen Schutz. *Beih. Veröff. Naturschutz Landschaftspflege Bad.-Württ.*, 48 : 25 - 53.

JAKOBER, H. & STAUBER, W. (1987b) : Dispersionsprozesse in einer Neuntöter-Population. *Beih. Veröff. Naturschutz Landschaftspflege Bad.- Württ.*, 48 : 119 - 130.

JAKOBER, H. & STAUBER, W. (1987c) : Artenhilfsprogramm Neuntöter. pp. 570 - 581, 1178 - 1185 *in* J. HÖLZINGER, HRSG. : *Die Vögel Baden-Württembergs (Avifauna Baden - Württemberg)*, Bd.1. Gefährdung und Schutz: Artenhilfsprogramme. Stuttgart (E. Ulmer), 1797pp.

JÄRVINEN, O., & VAÏSÄNEN, R.A. (1978). Long-term population changes of the most abundant south Finnish forest birds during the past 50 years. *J.Orn.*, 119 : 441 - 449.

KORODI GAL, I. (1969) : Beiträge zur Kenntnis der Brutbiologie und Brutnahrung der Neuntöter (*Lanius collurio* L.). *Zoologische Abhandlungen Staatliches Museum für Tierkunde in Dresden*, 30 : 57 - 82.

KOWALSKI, H. (1984) : Artenhilfsprogramm Rotrückenwürger Laniidae *Lanius collurio*. *Merkblätter zum Biotop- und Artenschutz*. Recklinghausen.

KOWALSKI, H. (1987a) : Zur Bestandssituation des Neuntöters (*Lanius collurio*) in der BRD und in Westberlin. *Beih. Veröff. Naturschutz Landschaftspflege Bad.-Württ.*, 48 : 17 - 23.

KOWALSKI, H. (1987b) : Die Verbreitung des Neuntöters *Lanius collurio* in Nordrhein-Westfalen. *Charadrius*, 23 : 12 - 27

KUSSMAUL, K. (1987) : Zur Situation des Neuntöters in der Rheinebene bei Karlsruhe. *Beih. Veröff. Naturschutz Landschaftspflege Bad.-Württ.*, 48 : 83 - 92

KWAK, R. & STRONKS, J. (1993) : Heeft de Grauwe Klauwier een toekomst in het kleinschalige cultuurlandschap? *Vogeljaar*, 41 : 20 - 25.

LEFRANC, N. (1993) : *Les Pies-grièches d'Europe, d'Afrique du Nord et du Moyen-Orient*. Delachaux et Niestlé S.A., Lausanne (Suisse). Paris.

MANN, W. (1983) : Zur Ernährung des Neuntöters *Lanius collurio* in Abhängigkeit vom Insektenangebot auf verschiedenen Dauergrünlandtypen. *Vogelkundl. Heft Edertal*, 9 : 5 - 41.

MANN, W. & BRANDL, R. (1986) : Nestlingswachstum und Niederschläg beim Neuntöter. *Journal für Ornithologie*, 127 : 97 - 98.

MANSFELD, K. (1958) : Zur Ernährung des Rotrückenwürgers (*Lanius collurio collurio* L.), besonders hinsichtlich der Nestlingsnahrung, der Vertilgung von Nutz- und Schadinsekten und seines Einflusses auf den Singvogelbestand. *Beitr. z. Vogelk.*, 6 : 271 - 292.

MARÉCHAL, P. (1993) : Over externe factoren die de habitatkwaliteit van de Grauwe Klauwier *Lanius collurio* beinvloeden. *Vogeljaar*, 41 : 34 - 48.

MASSA, R., BOTTONI, L. & FORNASARI, L. (1993) : Site fidelity and population structure of the Red-backed shrike *Lanius collurio* in Northern Italy. *Ringing and Migration*, 14 : 129 - 132.

MIELEWCZYK, S. (1967) : On the food of the Red-backed Shrike, *Lanius collurio* L., near Gniezno (prov. of Poznan). *Acta ornithologica*, 6 : 159 - 175

MOES, M. (1993) : Habitatnutzung beim Neuntöter (*Lanius collurio*). *Regulus Wiss. Ber.*, 12 : 1 - 26.

MORRIS, M.G. (1978) : Grassland management and invertebrate animals: a selective review. *Sci. Proc. Royal Dublin Society*, 6 : 247 - 257.

MÜNSTER, W. (1958) : *Der Neuntöter oder Rotrückenwürger*. Wittenberg Lutherstadt.

OWEN, J.H. (1948) : The larder of the Red-backed Shrike. *British Birds*, 41 : 200 - 203.

PEAKALL, D.B. (1962) : The past and present status of the Red-backed Shrike in Great Britain. *Bird Study*, 9 : 198 - 216.

PFISTER, H.P. & NAEF-DAENZER, B. (1987). Der Neuntöter und andere Hecken-Brüter in der modernen Kulturlandschaft. *Beih. Veröff. Naturschutz Landschaftspflege Bad. Württ.*, 48 : 147 - 158.

POLTZ, W. (1975) : Über den Rückgang des Neuntöters *Lanius collurio*. *Vogelwelt*, 96 : 1 - 19.

RATZKE, B. & SCHRECK,, W. (1992) : Spontane Wiederbesiedlung und hohe Siedlungsdichte des Neuntöters nach Biotoppflegemaßnahmen auf der ehemaligen Mülldeponie Berlin-Wansee. *Berliner Orn. Ber.*, 2 : 32 - 37.

ROTHHAUPT, G., KLEIN, H. (1998) : Usable area as a key factor for habitat occupancy in the Great Grey Shrike *Lanius excubitor*. *In* YOSEF, R. & LOHRER F.E. (ed.) : Shrikes of the world : conservation implementation. Proc. of the 2nd International Shrike Symposium 17-23 March 1996, Eilat, Israel. *I.B.C.E. Tech. Publ.* 7: 64 - 67.

SCHÄFER, M., SCHUMACHER, H. & STROTHMANN, U. (1996) : *Untersuchungen zur Habitatwahl des Neuntöters* Lanius collurio *L. auf dem Kerstlingeröder Feld bei Göttingen (Südniedersachsen) 1996*. Thesis Zentrum für Naturschutz, Universität Göttingen.

SCHIFERLI, L. & BIBER, O. (1987) : *Les Oiseaux et L'Agriculture*. Station Ornithologique Suisse de Sempach.

SCHÖN, M. (1994) : Characteristics of the Habitats of the Great Grey Shrike *Lanius e. excubitor* in the Region of the Southwestern Schwäbische Alb, Southwestern Germany : seasonal utilization and territorysize, structural characteristics and their changes, microstructures and cultivation. *Ökol. Vögel* (Ecol. Birds), 16 : 253 - 496.

SCHÖN, M. (1998) : Conservation measures and realisation of the Great Grey Shrike *Lanius excubitor* in the region of the southwestern Schwäbische Alb. *In* YOSEF, R. & LOHRER F.E. (ed.) : Shrikes of the world : conservation implementation. Proc. of the 2nd International Shrike Symposium 17-23 March 1996, Eilat, Israel. *I.B.C.E. Tech. Publ.* 7: 68 - 73.

SMITH, E.L. & KRUSE, K.C. (1992) : The relationship between land-use and the distribution and abundance of Loggerhead Shrikes in South-Central Illinois. *J. Field Ornothol.*, 63 : 420 - 427.

SPENCER, R. & THE RARE BREEDING BIRDS PANEL (1993) : Rare breeding birds in the UK in 1990. *British Birds*, 86 : 62 - 90.

STAUBER, W. & ÜLLRICH, B. (1970) : Der Einfluss des nasskalten Frühjahres 1969 auf eine Population des Rotrücken würgers *Lanius collurio* und Rotkopfwürgers *Lanius senator* in Südwestdeutschland. *Vogelwelt*, 91 : 213 - 222.

SUTOR A. (1995) : *Hecken und Waldränder als Lebensraum für Vögel der Agrarlandschaft*. Thesis, Ludwig-Maximilians-Universität München.

TUCKER, G.M., HEATH, M.F., TOMIALOJC, L. & GRIMMETT, R.F.A. (1994) : *Birds in Europe: Their Conservation Status*. Birdlife International, Cambridge.

VAN BERKEL, J. (1993) : De Grauwe Klauwier in het Bargerveen gedurende de jaren 1978 tot en met 1990. *Vogeljaar*, 41 : 26 - 33.

VANDEKERKHOVE, K. (1993) : Populatiedynamiek van de Grauwe Klauwier *Lanius collurio* in Europa. *Het Vogeljaar*, 42 : 211 - 215.

VAN DER BILT, E.W.G. (1989) : Extensieve begrazing met heideschapen. *De Levende Natuur*, 89 : 130 - 136.

VAN NIEUWENHUYSE, D. (1992) : Evolution du statut de la Pie-grièche écorcheur *Lanius collurio* dans la région de Virton (Lorraine belge). *Aves*, 29 : 216 - 220.

VAN NIEUWENHUYSE, D., COUSSENS, P. & NOLLET, F. (1995) : Digital method for recording and analyzing the territory use and activity budget of the Red-backed Shrike *Lanius collurio*. *In* YOSEF, R. & LOHRER, F.E. (ed.) : Shrikes (*Laniidae*) of the world : biology and conservation. Proceedings of the 1st International Shrike Symposium. *West Found. Vert. Zool.*, 6 : 268 - 275.

VAN NIEUWENHUYSE, D. & VANDEKERKHOVE, K. (1989) : Populatiestijging van de Grauwe Klauwier *Lanius collurio* in het zuiden van de Gaume (België) in de periode 1979-1988. *Oriolus*, 55 : 60 - 65.

VAN NIEUWENHUYSE, D. & VANDEKERKHOVE, K. (1992) : Caractéristiques et typologie des territoires de la Pie-grièche écorcheur *Lanius collurio* en Lorraine belge. *Aves*, 29 : 137 - 154.

VAN WINGERDEN, W.K.R.E., MUSTERS, J.C.M., KLEUKERS, R.M.J.C., BONGERS. W. & VAN BIEZEN, J.B. (1991) : The influence of cattle grazing intensity on grasshopper abundance (*orthoptera : Acrididae*). *Proc. Exper. & Appl.Entomol., N.E.V. Amsterdam*, 2 : 28 - 34.

VAN WINGERDEN, W.K.R.E., VAN KREVELD, A.R. & BONGERS, W. (1992) : Analysis of species composition and abundance of grasshoppers (*Orth., Acrididae*) in natural and fertilized grasslands. *J. Appl. Ent.*, 113 : 138 - 152.

VAN WINKEL, J. (1967) : Verkenning naar de ekologische karakteristieken van het Grauwe Klauwierbiotoop (*Lanius collurio*) in Noord-Limburg. *De Wielewaal*, 33 : 65 - 75, 97 - 108

WAGNER, T. (1993) : Saisonale Veränderungen in der Zusammensetzung der Nahrung beim Neuntöter (*Lanius collurio*). *J. f. Orn.*, 134 : 1 - 11.

YOSEF, R, (1993) : Influence of observation posts on territory size of Northern Shrikes. *Wilson Bulletin*, 105 : 180 - 183.

YOSEF, R. & GRUBB, T. C. (1993) : Effect of vegetation height on hunting behavior and diet of Loggerhead Shrikes. *The Condor*, 95 : 127 - 131.

ZWÖLFER, A. (1989) : Courtship feeding and clutch size in Red-backed Shrikes (*Lanius collurio*). *Amer.Nat.*, 133 : 454 - 457.

ZWÖLFER, H., BAUER, G., HEUSINGER, G. & STECHMANN, D. (1984) : Die tierökologische Bedeutung und Bewertung von Hecken. *Berichten der Akademie für Naturschutz und Landschaftspflege*, 3 : 1 - 155.