

**HABITAT SELECTION AND REPRODUCTIVE BIOLOGY OF THE LOGGERHEAD
SHRIKE IN EASTERN ONTARIO AND QUEBEC**

by

AMY A. CHABOT

A thesis submitted to the Faculty of Graduate Studies
and Research of McGill University in partial fulfilment of
the requirements for the degree of Master of Science

Department of Natural Resource Sciences
Macdonald Campus of McGill University
Montreal, Quebec

© Amy A. Chabot January 1994

Suggested short title:

Breeding biology of the Loggerhead Shrike in eastern Canada.

ABSTRACT

The status and distribution of Loggerhead Shrikes (*Lanius ludovicianus*) in southern Ontario and Quebec was studied during the 1991 and 1992 breeding seasons. Shrikes returned from wintering areas in April and egg laying began by the end of April and early May. The population of Loggerhead Shrikes in eastern Ontario was found to consist of 51 pairs distributed over three core areas, each associated with a limestone plain. Only one pair of birds was found breeding in the province of Quebec in 1991 and 2 in 1992. Shrikes nested in hawthorn (*Crataegus* spp.), red cedar (*Juniperus virginiana*) and other species, most often in actively grazed pastures. Suitable historic nesting sites were reoccupied and there was a high rate of reoccupancy of 1991 sites in 1992. Breeding territory selection was affected by the amount of habitat fragmentation around a site, but nest site selection appeared to be random within a suitable territory. Shrikes nesting in Ontario have a high rate of reproductive success (58 to 93%). The number of fledglings per nest is high, however, only half survive the 3 to 4 weeks needed to become independent of their parents (2.30 of 3.90 in 1991 and 2.50 of 4.17 in 1992). Shrikes were found to renest several times and double brooding was observed. More time was spent hunting and feeding mates and young as the demand for food increased through the reproductive cycle.

RÉSUMÉ

Une étude sur le statut et la distribution de la pie-grièche migratrice (*Lanius ludovicianus*) a été effectuée dans le sud de la province d'Ontario et dans la province de Québec durant les saisons estivales de 1991 et 1992. Les pie-grièches sont revenues de leurs aires d'hivernage au mois d'avril et ont commencé la ponte à la fin du mois d'avril et début mai. Dans l'est de la province d'Ontario, la population des pie-grièche était constituée de 50 couples distribués dans 3 régions principales, chacune associée avec une plaine calcareuse. Au Québec, un seul couple d'oiseaux s'est reproduit durant l'année 1991 et 2 couples en 1992. La population Ontarienne doit être considérée comme réservoir vital pour cette espèce. Durant l'étude, les pie-grièches ont le plus fréquemment niché dans des pâturages activement broutés, dans les aubépines (*Crateagus spp.*) et dans les genevriers de Virginie (*Juniperus virginiana*) et parfois dans certaines autres espèces. Il a été découvert que plusieurs habitats historiques propre à la pie-grièche migratrice ont été réutilisés et de plus plusieurs sites occupés en 1991 ont été réutilisés en 1992. Le territoire choisi par la pie-grièche est influencé par le niveau de fragmentation de l'habitat qui entoure un site, mais le choix du site de nidification semble être effectué au hasard à l'intérieur de l'habitat propre à la pie-grièche. Les pie-grièches nichant dans la province de l'Ontario ont un taux élevé de succès reproductif, par contre, seulement la moitié des jeunes capables de s'envoler ont survécu la période de 3 ou 4 semaines avant qu'il deviennent

indépendent des parents. Les pie-grièche migratrice du sud de l'Ontario nicheront plusieurs fois, si nécessaire, durant la période de reproduction et une deuxième couvée a été observée durant l'étude parmi certains couples. Ces oiseaux passent le plus de temps à nourrir leur partenaire et leurs jeunes, en relation avec une demande de nourriture augmentée durant la période de reproduction.

TABLE OF CONTENTS

LIST OF TABLES	viii
LIST OF FIGURES	xiii
ACKNOWLEDGEMENTS	xiv
PREFACE	xvi
SECTION 1: LITERATURE REVIEW	1
Taxonomy, Status and Distribution	1
Distinguishing Characteristics	3
Site Fidelity	5
Territory Size and Defense	5
Courtship	6
Breeding Biology	7
Habitat Requirements	10
Foraging Ecology	11
Possible Causes of Decline	13
Official Designation and Study Objectives	20
Literature Cited	22
CONNECTING STATEMENT	29
SECTION 2: POPULATION DISTRIBUTION AND TRENDS OF THE LOGGERHEAD SHRIKE IN ONTARIO AND QUEBEC	30
Abstract	31
Introduction	32

Study area	33
Methods	35
Results	38
Discussion	41
Literature Cited	44
 CONNECTING STATEMENT	 62
 SECTION 3: HABITAT SELECTION OF LOGGERHEAD SHRIKES	
BREEDING IN ONTARIO AND QUEBEC	63
Abstract	64
Introduction	65
Study area	66
Methods	66
Results	71
Discussion	75
Literature Cited	83
 CONNECTING STATEMENT	 101
 SECTION 4: REPRODUCTIVE PERFORMANCE OF LOGGERHEAD	
SHRIKES IN ONTARIO	102
Abstract	103
Introduction	104
Study area	105
Methods	105

Results	107
Discussion	109
Literature Cited	114
 CONNECTING STATEMENT	 128
 SECTION 5: HABITAT UTILIZATION BY LOGGERHEAD SHRIKES	
IN ONTARIO	129
Abstract	130
Introduction	130
Study area	132
Methods	132
Results	133
Discussion	136
Literature Cited	140
 CONNECTING STATEMENT	 155
 SECTION 6: CONCLUSION AND MANAGEMENT SUGGESTIONS	 156
Conclusion	157
Management Suggestions	158

LIST OF TABLES

Page No.

SECTION 1:

Table 1.1. Typical plant species found in Loggerhead Shrike habitats in southern Ontario.	48
Table 1.2. Number of 10 by 10 km squares with confirmed evidence of breeding Loggerhead Shrikes in southern Ontario in 1981-1985 (Cadman et al. 1987), 1991 and 1992.	50
Table 1.3. Number of breeding pairs of Loggerhead Shrikes in southern Ontario and Quebec in 1991 and 1992.	51
Table 1.4. Number of 1991 territories reoccupied by breeding pairs and percent reoccupancy by Loggerhead Shrikes in 1992 in southern Ontario and Quebec.	52
Table 1.5. Number of suitable, no longer suitable and reoccupancy rate of historic sites by Loggerhead Shrikes in southern Ontario.	53

SECTION 2:

Table 2.1. Number of hawthorn, red cedar and other species of trees used as nesting sites by Loggerhead Shrikes in the three core areas of shrike breeding population in southern Ontario in 1991 and 1992.	88
Table 2.2. Spatial relationship of nest trees chosen by Loggerhead Shrikes in the three core areas in southern Ontario in 1991 and	

- Table 2.3. Land use classification of active Loggerhead Shrike breeding territories in southern Ontario in each of the three core areas of Loggerhead Shrike breeding population in southern Ontario in 1991 and 1992. 90
- Table 2.4 Mean ($\pm$ S.E.) height (m), width (m) and concealment (%) of Loggerhead Shrike nest trees, nearest suitable neighbour and arbitrarily chosen trees in suitable unoccupied sites in southern Ontario in 1991 and 1992. 91
- Table 2.5. Mean ($\pm$ S.E.) height of vegetation (cm) within a 10 m radius of the nest tree of Loggerhead Shrikes and arbitrarily chosen trees at suitable unoccupied sites in southern Ontario during 1991 and 1992. 92
- Table 2.6. Mean ($\pm$ S.E.) composition of ground cover on a scale of 1 to 5 (1= 0-12%, 2= 12-25%, 3= 25-50%, 4= 50-75%, 5= < 75%) within a 10 m radius of the nest tree of Loggerhead Shrikes and arbitrarily chosen trees at suitable unoccupied sites in southern Ontario during 1991 and 1992. 93
- Table 2.7. Mean ($\pm$ S.E.) shrub and tree density per acre within a 200 meter radius of the nest tree of Loggerhead Shrikes and arbitrarily chosen trees at suitable unoccupied sites in southern Ontario during 1991 and 1992. 94
- Table 2.8. The mean ($\pm$ S.E.) distance (m) to the nearest road, house and other source of disturbance at active isolated hawthorn, hedgerow hawthorn, isolated red cedar and other isolated species of Loggerhead Shrike territories and suitable

unoccupied sites in the three core areas of breeding population in southern Ontario during 1991 and 1992. 95

Table 2.9. The mean ($\pm$ S.E.) distance (m) to the nearest road, house, other source of disturbance and traffic volume per hour at active Loggerhead Shrike territories and suitable unoccupied sites in the three core areas of breeding population in southern Ontario during 1991 and 1992. 96

Table 2.10. Number (mean $\pm$ S.E.) of hectares of potential Loggerhead Shrike habitat within a 400 m radius of isolated hawthorn, hedgerow hawthorn, isolated red cedar and other isolated species at active nest trees and arbitrarily chosen trees in suitable unoccupied sites in southern Ontario. 97

Table 2.11. Number (mean $\pm$ S.E.) of hectares of potential Loggerhead Shrike habitat within a 400 m radius at active nest sites and arbitrarily chosen trees in suitable unoccupied sites in the three core areas of breeding population in southern Ontario. 98

Table 2.12. Number (mean $\pm$ S.E.) of hectares of potential Loggerhead Shrike habitat within a 1 km radius around active nest sites and arbitrarily chosen trees in suitable unoccupied sites in the three core areas of breeding population in southern Ontario. 99

Table 2.13. Number (mean $\pm$ S.E.) of hectares of potential Loggerhead Shrike habitat within a 5 km radius of active Loggerhead Shrike territories, suitable unoccupied sites and historic nest sites in southern Ontario and Quebec. 100

SECTION 3:

Table 3.1. Number of breeding pairs and nests found and percent of Loggerhead Shrikes breeding in southern Ontario in 1991 and 1992.	118
Table 3.2. Mean ($\pm$ S.E.) number of eggs, mode, range and total number of Loggerhead Shrike eggs observed in southern Ontario in 1991 and 1992.	119
Table 3.3. Summary (mean $\pm$ S.E.) of the reproductive effort of Loggerhead Shrikes breeding in southern Ontario in 1991 and 1992.	120
Table 3.4. Daily nest survival for any egg laid in isolated hawthorn, hedgerow hawthorn, isolated red cedar and other species of nest tree as calculated according to the Mayfield method (1975) for Loggerhead Shrikes breeding in southern Ontario in 1991 and 1992.	121
Table 3.5. Probability of survival for any egg laid in isolated hawthorn, hedgerow hawthorn, isolated red cedar and other species of nest tree as calculated according to the Mayfield method (1975) for Loggerhead Shrikes breeding in southern Ontario in 1991 and 1992.	122
Table 3.6. Mean ($\pm$ S.E.) depth (cm), height (m) and placement (main trunk, MT; main branch, MB; canopy centre, CC; canopy edge, CE) of nests hawthorn, red cedar and other species of nesting trees chosen by Loggerhead Shrikes in southern Ontario during 1991 and 1992.	123

SECTION 4:

- Table 4.1. Mean ($\pm$ S.E.) percentage of time breeding Loggerhead Shrikes in southern Ontario were observed engaged in various activities during 218 hours of observations in 1991 and 1992. 144
- Table 4.2. Hunting rate (mean $\pm$ S.E.) per hour during all stages of the reproductive cycle by breeding Loggerhead Shrikes in southern Ontario during 218 hours of observations in 1991 and 1992. 147
- Table 4.3. Prey delivery rate (mean $\pm$ S.E.) per hour during all stages of the reproductive cycle by breeding Loggerhead Shrikes in southern Ontario during 218 hours of observations in 1991 and 1992. 148
- Table 4.4. Frequency (number of times observed) of associated bird species observed at Loggerhead Shrike nesting sites in the three core areas of breeding concentration in southern Ontario during 1991 and 1992. 149
- Table 4.5. Associated bird species observed engaged in aggressive interactions with Loggerhead Shrikes in southern Ontario during 1991 and 1992. 154

LIST OF FIGURES

Page No.

SECTION 1:

- Figure 1.1. All 10 by 10 km Ontario Breeding Bird Atlas squares with probable or confirmed evidence of breeding Loggerhead Shrikes during the 5 year period 1981-1985 (Cadman *et al.* 1987) 54
- Figure 1.2. All 10 by 10 km Ontario Breeding Bird Atlas squares with confirmed evidence of breeding Loggerhead Shrikes in 1991 (Cuddy 1993). 56
- Figure 1.3. All 10 by 10 km Ontario Breeding Bird Atlas squares with confirmed evidence of breeding Loggerhead Shrikes in 1992 (Cuddy 1993). 58
- Figure 1.4. "Improved" land as a percentage of farm land in southern Ontario according to the 1976 census of agriculture (Cadman *et al* 1987). 60

SECTION 3:

- Figure 3.1. Timing of reproduction by Loggerhead Shrikes breeding in southern Ontario in 1991. 124
- Figure 3.2. Timing of reproduction by Loggerhead Shrikes breeding in southern Ontario in 1992. 126

ACKNOWLEDGEMENTS

I am grateful to my advisors, Dr. Rodger Titman and Dr. David Bird, for allowing me the chance to work with the Loggerhead Shrike. I am indebted to Marie-Christine Paquin, Isabelle Bisson, Glenn Barrett, Andre Chabot and Peter Judge for their assistance with field work. I would like to thank Karen Bellamy, Ron Pittaway, Tim Haxton, Chris Grooms and the many other employees of the Ontario Ministry of Natural Resources for their support and encouragement. I owe a great deal of thanks to Don Cuddy of the Ontario Ministry of Natural Resources in particular for his tireless advice, encouragement and logistic support. I am grateful to Pierre Laporte of the Canadian Wildlife Service in Quebec for his collaboration in this project in Quebec. It is with much gratitude that I thank my parents, and my father in particular, for all of their efforts to keep me (and the Volvo) on the road and seeing me through to the completion of my degree. I am grateful to the farmers who granted me access to their land and for making me feel at home. In addition I sincerely thank Mike Runtz, Ron Curtis, Nora Mansfield, Annette Mess, Bob Bowles, Jim Ferguson, Bruce DiLabio, Ed Czerwinski and the many other volunteers who spent countless hours contributing to the successful completion of this project. Funding for this research was provided by Challenge 1991, the Fondation de la Faune du Quebec, the Fondation pour la Sauvegarde des Espèces Menacées, McGill University, the Natural Sciences and Engineering Research Council of Canada, the Province of Quebec Society for the Protection of Birds, the Ontario Ministry

of Natural Resources and World Wildlife Fund Canada.

PREFACE

This thesis comprises six sections which deal with habitat selection and reproductive biology of the Loggerhead Shrike (*Lanius ludovicianus migrans*) in eastern Ontario and Quebec. The first section is an overview of pertinent literature on the Loggerhead Shrike. The second section deals with the population distribution and trends of the Loggerhead Shrike in Ontario. The third and fourth sections focus on the habitat selection of Loggerhead Shrikes breeding in Ontario and Quebec and the reproductive performance of the shrike in Ontario respectively. The fifth section examines habitat utilization of the Loggerhead Shrike in Ontario. The last section is a summary of the findings and management suggestions. All of the sections are written following the guidelines set out by the Canadian Journal of Zoology.

The following is included in accordance with the McGill University Faculty of Graduate Studies:

"The candidate has the option, subject to the approval of the Department of including, as part of their thesis, copies of the text of a paper(s), provided that these copies are bound as an integral part of the thesis. In this case the thesis must still conform to all other requirements of the "Guidelines Concerning Thesis Preparation" and should be in a literary form that is more than a mere collection of manuscripts published or to be published. The thesis must include, as separate chapters or sections: (1) a Table of Contents, (2) a general abstract in English and French, (3) an introduction which clearly states the rationale and

objectives of the study, (4) a comprehensive general review of the background literature to the subject of the thesis, when this review is appropriate, and (5) a final overall conclusion and/or summary. Additional material (procedural and design data, as well as description of equipment used) must be provided where appropriate and in sufficient detail (e.g. in appendices) to allow a clear and precise judgement to be made of the importance and originality of the research reported in the thesis. In the case of manuscripts co-authored by the candidate and others, the candidate is required to make an explicit statement in the thesis of who contributed to such work and to what extent; supervisors must attest to the accuracy of such claims at the Ph.D. oral defense. Since the task of the examiners is made more difficult in these cases, it is in the candidate's interest to make perfectly clear the responsibility of the different authors or the co-authored papers."

The data for sections 2, 3, 4 and 5 were collected and analyzed by A.A. Chabot. R.D. Titman and D.M. Bird provided the basis for the study and editorial assistance and appear as coauthors of all four papers. D.G. Cuddy provided technical assistance and advice particularly in the collection of data to determine the population distribution and trends in Ontario and appears as a coauthor in the first paper.

SECTION 1:

LITERATURE REVIEW

Taxonomy, Status and Distribution:

The family Lanidae (Passeriformes) includes 74 species, divided among 12 genera (Rand 1960, Raikow et al. 1980). Two species of shrike are found in North America: *Lanius excubitor* the Northern or Great Grey Shrike which includes two subspecies and *Lanius ludovicianus*, the Loggerhead Shrike. Of the 11 subspecies of Loggerhead Shrike found in North America, 3 breed in Canada. Canada's third subspecies of Loggerhead Shrike, *Lanius ludovicianus gambeli*, is a bird of the northwestern United States which has been observed on occasion in southern British Columbia and appears to migrate south into southeastern California, southern Arizona and into western Mexico (Miller 1931).

Lanius ludovicianus excubitorides, the western subspecies, is a bird of the Great Plains east of the Rocky Mountains. It is found in great numbers in Saskatchewan and has a population of a few hundred breeding pairs in Manitoba and Alberta. The western subspecies migrates to and winters in eastern New Mexico and western Texas south through Mexico where it is principally found on the northeast coast and plateau districts (Miller 1931). Recent banding returns have also placed wintering birds in eastern, central and northern Texas, Oklahoma and Missouri. Range expansion occurred northward where settlements and clearings created suitable habitat in Saskatchewan and Alberta (Godfrey 1986). There is

evidence of a recent retraction of northern distribution and an overall southerly retraction of distribution (Cadman 1985). Despite this the range of breeding population of the western race in the Prairie Provinces appears to be stable.

Lanius ludovicianus migrans was first recorded in eastern Canada in 1860 (McIlwraith 1886) and its range has changed considerably since then. Its range expanded north and eastward throughout the 20th century with the clearing of land for agricultural purposes and settlement (Forbush 1939). The migrant eastern subspecies has historically bred from New Brunswick, Nova Scotia, southern Quebec and Ontario, the north Atlantic states, and New England, south to Kentucky, Tennessee and Indiana. However, the species range has been gradually contracting since the 1940's (Cadman 1985). While never a common breeder, the Loggerhead Shrike is no longer found in the Northeastern Maritime Region (Maritime Provinces, Maine, New Hampshire, Massachussetts, Connecticut and Rhode island). The species is virtually extirpated in Quebec and the population has declined drastically in Manitoba. In Ontario, losses are greatest from the northern and southern portions of its range (Cadman 1985). While small in numbers the population in Ontario now represents the stronghold for the eastern subspecies in eastern Canada.

The wintering range of the eastern subspecies breeding in Canada is not known. However, Miller (1931) gives the winter distribution of *L. l. migrans* to be Virginia, North Carolina, Mississippi, Louisiana, eastern Texas, and into South Carolina,

Georgia, Alabama, and the eastern coast of Mexico where resident populations are found. In addition, Graber *et al.* (1973) stated that there is a notable winter population in southern Illinois. In general Miller (1931) believed that birds from snowy areas tended to leave areas where snow was on the ground more than 10 days a year.

Distinguishing Characteristics:

Miller (1931) described both the Loggerhead Shrike's appearance and the distinguishing characteristics of the subspecies. His account, summarized below, remains the most complete reference on shrike natural history. The plumage of the adults, juveniles and first year birds is not sexually dimorphic and sex cannot be determined by body shape or size. The adult breeding plumage of the migrant shrike is a neutral grey on the underparts fading to white at the edge of the facial mask. It possesses a black facial mask which meets above the bill. The wings are black with characteristic white wing patches located on the primaries which are best seen in flight. The bill is black, moderately curved with a short hook, and possesses a tomial tooth. The tarsus and feet are black while the iris is brown.

First year birds in breeding plumage are similar to adults and while they have undergone an incomplete molt, most of the flight feathers are juvenal and possess buff tips. While juvenile birds closely resemble the adults, there are some subtle differences. The underparts of juvenile birds are vermiculated and the white

areas of the wings and tail are buffy while the upperparts have pale buff or smoke grey tips. Juveniles can be distinguished from adults by the vermiculation of black edging on contour feathers as well.

The migrant subspecies of Loggerhead Shrike can be distinguished from the Northern or Great Grey Shrike (*Lanius excubitorides*) mainly by coloration, size and bill length. The Great Grey Shrike is larger and longer than the Loggerhead Shrike, with a larger head and longer, heavier and more sharply hooked bill. Barring is often visible on the breast of the Great Grey as well. Perhaps one of the most distinguishing differences is the facial mask which meets above the mandible in the Loggerhead Shrike while flecks of grey in the Great Grey Shrike create a discontinuous mask. The nasal tufts of the Loggerhead Shrike are black, while those of the Great Grey Shrike are white. Their behaviour is somewhat different as well. Other distinguishing characteristics have been discussed by Zimmerman (1955) but due to variation in both the Loggerhead Shrike and the Great Grey Shrike they are not always accurate indicators of the species.

The eastern subspecies of Loggerhead Shrike (*Lanius ludovicianus migrans*) can be distinguished from the western subspecies (*L. l. excubitorides*) by wing and tail length and colour. According to Zimmerman (1955) the wings of *L. l. migrans* are longer than the tail and the forehead is paler than the top of the head. The slate colour of the sides extends across the breast and the upper tail coverts are paler than the back. The wings of

L. l. excubitorides are shorter than the tail and the forehead is the same colour as the head and the upper tail coverts are the same dark slate colour as the back.

Site Fidelity:

Loggerhead Shrikes breed in their first spring and exhibit annual monogamy (Miller 1931). The degree of site fidelity exhibited by the Loggerhead Shrike is in dispute. Atkinson (1901), Miller (1931) and Bent (1950) believed that shrikes used the same territory for up to ten consecutive years. More recently, Campbell (1975) believed site fidelity to be a well known phenomenon in Loggerhead Shrikes based on observation of Ontario birds using sites for two or more years. However, Kridelbaugh (1983) found male shrikes to exhibit only a 54% reoccupation rate, with no females returning to the same territory. Haas and Sloan (1989) also reported a very low return rate of 14 % for banded shrikes over a three year period which they attributed to desertion of nests and mate switching by females. The discrepancy may also be due in part to a lack of distinction between the reuse of territories and reoccupancy by the previous years breeders at a site.

Territory Size and Defense:

Miller (1931) reported that the territory size occupied by Loggerhead Shrikes averaged 11 to 15 ha but became larger (13-40 ha) in desert areas. Hartley (1980) estimated territory size to be

approximately 25 ha in Victoria County, Ontario. However, Kridelbaugh (1983) estimated territory sizes of shrikes to be only 4.6 ha in size. While there have been cases of pairs nesting in close proximity to each other (Bent 1950, Cadman 1985), most pairs usually defend larger territories and Porter *et al.* (1975) believed that shrikes would not nest closer together than 400 m.

Males defend territories through the use of song (Bent 1950), visual displays in which the white markings on their wings and tail are flashed (Tracy 1910, Miller 1931) and pursuit flights accompanied by the defending male emitting "bzeek" calls (Miller 1931). If these tactics are not sufficient and the two males approach each other again, a "flutter" display results (Smith 1973a). The subordinate male responds through posturing which inhibits further aggressive action.

Courtship:

Both sexes vocalize, although neither sex is known for its vocal abilities. The male's territorial song consists of rhythmic, metallic screeches and trills usually given when the pair is separated. The female's song is lower pitched and not as powerful as the male's (Bent 1950). In addition the male performs a nuptial flight during courtship which consists of erratic zigzagging, vertical undulations and changes of pace. Males also hover at a greater height than normally used for hunting and occasionally chase the female. When faced with his potential mate the male's sexual posturing consists of fluttering his wings and spreading his

tail (Miller 1931, Bent 1950, Smith 1973a). Courtship feeding of the female by the male does occur in Loggerhead Shrikes. The female crouches with head up, wings drooped and fluttering while she emits begging notes resembling a hungry fledgling (Smith 1973a).

Breeding Biology:

Both sexes participate in the selection of a nesting site. Many potential sites are inspected until a site is selected and nest building is begun at which time the searching behaviour stops (Miller 1931). Nest site selection is believed to be based on the degree of cover provided rather than on the particular tree species. However, if present, thorn bearing trees are usually selected probably due to the increased protection from predation (Porter et al. 1975). Tree species utilized for nest sites include: honey locust (*Gleditsia tricanthas*), osage orange (*Maclura pomifera*), apple trees (*Pyrus malus*), oaks (*Quercus* sp.), hawthorn bushes (*Crataegus* sp.), wild plum (*Prunus americana*), elm (*Ulmus* sp.), spruce (*Picea* sp.), grapevine (*Vitis* sp.), red cedar (*Juniperus virginiana*), hackberry (*Celtis* sp.), mulberry (*Morus* sp.), chittamwood (*Bumelia lanuginosa*), cottonwood (*Populus deltoides*), black willow (*Salix nigra*), black locust (*Robinia pseudo-acacia*), black cherry (*Prunus serotina*), persimmon (*Diospyros virginiana*), white cedar (*Thuja occidentalis*), and pine (*Pinus* sp.) (Miller 1931, Bent 1950, Graber et al. 1973, Campbell 1975, Porter et al. 1975, Seigel 1980, Gawlick and Bildstein 1990,

Tyler 1992).

The female constructs the nest alone (Miller 1931). Miller (1931) characterized nest sites as being in dense bushes or small trees at medium heights (1-8 m). While there exists wide variability in nest design, in general the nest is a bulky structure of large twigs and a well-defined inner cup with a thick felt-like lining of grasses and hair providing good insulation for nestlings (Skowron and Kern 1980). Nests are usually placed either on large limbs or in the crotches of trees, however artificial structures such as ladders and abandoned buildings are used occasionally (Miller 1931, Bent 1950). Occasionally nests are constructed on top of existing shrike nests (Miller 1931).

Egg laying usually begins in late April and early May in Canada (Miller 1931), but clutches are initiated as early as February and March farther south (Bent 1950, Graber *et al.* 1973, Porter *et al.* 1975, Seigel 1980, Tyler 1992). The average clutch size is 5 or 6 eggs (Miller 1931, Graber *et al.* 1973, Campbell 1975, Seigel 1980), although Miller (1931) believed there to be a small increase in clutch size in the northern portion of the species range. Shrikes are penultimate incubators, resulting in the last egg hatching approximately 24 hours later than the others. Incubation is performed solely by the female who is fed by the male either on or off the nest during this period. The male tends to stay away from the nest tree but remains within 100 metres of it, allowing him to monitor alarm calls, begging notes or other displays by his mate. The nest is defended aggressively by both

sexes and nest desertion is rare.

The incubation period averaged 17 days in most studies but can be as low as 12 to 14 days (Miller 1931, Lohrer 1974, Porter *et al.* 1975, Kridelbaugh 1983, Tyler 1992). There appears to be great variation in the number of broods raised. Atkinson (1901) reported that shrikes raised at least three broods per season. Miller (1931) believed that shrikes typically raised two broods per season and Bent (1950) stated that the migrant race of shrikes often raised two broods in the north. Shrikes observed in short-grass prairies commonly renested if they lost their first clutch but raised only one brood per season (Porter *et al.* 1975). Other authors have found evidence of double brooding only occasionally (Bull 1974, Graber *et al.* 1975, Campbell 1975, Seigel 1980, Kridelbaugh 1983, Tyler 1992, Pittaway 1993). Cody (1966) believed that birds at lower latitudes raised more than one brood. Shrikes are extremely persistent breeders and have been observed to renest up to 5 (Miller 1931) and 6 (Atkinson 1901) times before successfully raising a brood. The construction of subsequent nests and clutch completion occurred very rapidly, between 10 to 12 days on average (Miller 1931).

The period required to raise a brood ranges from 17 to 20 days (Miller 1931, Lohrer 1974, Porter *et al.* 1975, Seigel 1980, Kridelbaugh 1983, Tyler 1992). The average number of young fledged per nest is 4 to 5 (Miller 1931, Graber *et al.* 1973, Porter *et al.* 1975, Anderson and Duzan 1978, Seigel 1980, Kridelbaugh 1982, Luukkonen 1987, Gawlick and Bildstein 1990). Nesting success has

been reported to range from 43 to 83% (Graber *et al.* 1973, Porter *et al.* 1975, Seigel 1980, Tyler 1992). Kridelbaugh (1983) stated that there was great variability in nesting success from year to year, but overall nesting success was high for an open cup nesting altricial bird in the north temperate zone. Other authors have confirmed the high nesting success (Miller 1931, Graber *et al.* 1973) but believed there to be high post-fledgling mortality which would require a high reproductive output to maintain population numbers. Miller (1931) believed that any decrease in reproductive output would lead to relatively rapid population decrease. Cadman (1985) stated that increased mortality of post-fledgling birds might be responsible for declining shrike numbers.

Habitat Requirements:

Habitat requirements have been identified by several authors (Atkinson 1901, Miller 1931, Bent 1950, Graber *et al.* 1973, Campbell 1975, Hartley 1980, Gawlick and Bildstein 1990, Smith and Kruse 1992, Prescott and Collister 1993). The shrike is essentially a bird of open country, however, small trees and shrubs are required as hunting perches and for territorial defense. Thick hedgerows are also used by shrikes. The presence of thorn trees is not vital but is characteristic of most areas where shrikes are found. Shrikes impale prey on sharp objects and thus impaling stations consisting of thorns, sharp twigs or barbed wire are typically present (Miller 1931). Preferred ground cover appears to be pasture and grazers are often present. Short grass appears to

be important to shrikes as it facilitates location and capture of prey. Campbell (1975) and Cadman (1985) both reported that the pastures in eastern Canada are often of poor quality for breeding shrikes. Loggerhead Shrikes use early successional stages in eastern Canada (Cadman 1985).

Foraging Ecology:

Shrikes are passerines that are opportunistic, living on the most abundant and readily obtainable animal food source. The food of different pairs varies according to their own territory and the needs of their young (Miller 1931). Shrikes possess various morphological modifications in keeping with their predatory habitats. They have a large head and a heavy beak with sharp hook and tomial tooth on the upper mandible used to dispatch vertebrate prey through disarticulation of the spinal cord. However, shrikes still have the perching feet characteristic of passerines, rather than the talons of raptors (Miller 1931) which creates problems in defense against larger prey and for holding onto prey once it has been killed. Shrikes are able to overcome the problem of defense by hovering over prey and biting at the base of the prey's skull. The second problem is overcome by securely impaling prey, enabling shrikes to tear at the prey using their beak. Shrikes hunt mainly using the sit and wait method, however, they will also hover (Miller 1931, Craig 1978, Mills 1979). Shrikes will either drop to the ground after prey or hawk after aerial insects. Active foraging tends to occur mainly in the early morning and at dusk

(Miller 1931). Shrikes normally forage from perches between 4 to 7 m in height (Morrison 1980). Their capture rate has been reported at 64% (Morrison 1980) and 65% (Craig 1978), which is greater than that found for other predatory species (Salt 1967). Young shrikes become proficient at prey capture at about 37 days of age (Smith 1973b), however, the extent to which the act of killing prey is dependent upon learning is in dispute (Smith 1973b, Busbee 1976).

The diet of the Loggerhead Shrike consists of both vertebrate and invertebrate prey and much work has been done in this area (Judd 1898, Beal and McAtee 1912, Miller 1931, Knowlton and Harmston 1944, Bent 1950, Balda 1965, Ellison 1971, Chapman and Casto 1972, Graber *et al.* 1973, Craig 1978, Morrison 1980). Miller (1931) gives one of the most comprehensive views. During the winter vertebrate prey constitutes up to 76% of the diet whereas during the remainder of the year it accounts for only 28%. Small mammals make up 3 to 55% of the food depending on season and location. Birds compromise less than 15% of the diet. In areas where reptiles are common (mainly the southwestern range of the shrikes), they will account for up to 8% of the food taken. Amphibians and fish constitute a very small proportion of their diet. Orthoptera make up 30 to 75% of the total food taken and are by far the most important prey items. Coleoptera comprise about 20%, while Lepidoptera constitute 4 to 7% of the diet. Hymenoptera make up only 3% of the diet in the eastern United States and other groups of insects constitute only a very small percentage of the

total food items.

The impaling behaviour of shrikes serves two purposes: to hold prey securely and to provide temporary storage for excess food (Wemmer 1969). Small prey items (less than 1 cm at its greatest dimension) are swallowed whole. Larger prey items are impaled and then torn into smaller pieces (Miller 1931). Several authors have discussed the secondary purpose of impaling prey for food storage (Watson 1910, Miller 1931, Bent 1950, Applegate 1977, Yosef and Pinshaw 1989). While there is much dispute as to a shrike's taste for food which has been impaled and become dried or spoiled, this form of prey storage could be significant during periods of adverse weather or decreased prey abundance and during the reproductive cycle. Miller (1931) found a direct correlation between hunger and impaling. Shrikes are more likely to impale prey as hunger decreases. Shrikes use a variety of implements for impaling and holding prey. Implement preference in the wild is determined by the most commonly encountered implement (Miller 1931). A variety of implements in an area results in the use of each to match the situation (Wemmer 1969).

Possible Causes of Decline:

While Loggerhead Shrikes were once considered to be abundant (Atkinson 1901, Miller 1931, Bent 1950), Mayfield (1949) noted a decline in the number of breeding birds as early as 1949. Other authors have voiced similar opinions (Peterson 1965, Erdman 1970). Loggerhead Shrikes have been reported on Breeding Bird Survey (BBS)

routes in 40 states and in 7 provinces. Since 1966 they have declined in 31 states and 5 provinces with only a single bird being reported in the other two provinces where the species occurs, making it impossible to identify a statistical trend (Cadman 1985). Significant decreases have occurred in 16 of the 31 states and 2 of the 5 provinces. Significant regional declines have occurred in eastern and central North America, while in the West declines have been shown to be non-significant (Geissler and Noon 1981). Cadman (1985) stated that according to BBS data there has been a marked decline in the abundance of Loggerhead Shrikes in Canada as well, indicating widespread declines throughout much of the species range. The Loggerhead Shrike has been on the Blue List since its inception in 1971. Christmas Bird Count data from 1955 to 1978 in the United States revealed similar trends (Morrison 1981). According to Arbib (1977), the Loggerhead Shrike was the "classic passerine Blue List species" as it had declined slowly and steadily, going from common to uncommon over much of its region. However, he believed that the listing should probably be limited to *L. l. ludovicianus* and *L. l. migrans*.

While several factors have been identified as being possibly important in explaining the species decline, the causes of shrike decline are not yet fully understood. A major cause of the decline of the Loggerhead Shrike may be through the loss and fragmentation of its habitat as a result of changes in land use (Graber et al. 1973, Bull 1974, Campbell 1975, Kridelbaugh 1981, Smith and Kruse 1992, Prescott and Collister 1993). Historically, the Loggerhead

Shrike was able to adapt to the grassland habitats associated with farming practices in Ontario and Quebec. However, within the last 50 years, much of this habitat has been lost due to changes in agricultural practices (decline of mixed farming, rationalization of dairy industry), development of rural lands for residential and other purposes and loss of open habitat through natural succession, reforestation and control of fires (Robert 1989). Cely and Corontzes (1986) suggested that increased farm size and succession of abandoned fields to woods affected South Carolina's shrike populations. Several researchers have attributed the decline to conversion of pastures and hayfields to rowcrops on both the breeding and wintering grounds (Kridelbaugh 1981, Smith and Kruse 1992, Telfer 1992). Hedgerows are indicated to be valuable to nesting shrikes (Atkinson 1901, Miller 1931, Bent 1950, Graber *et al.* 1973) and therefore, hedgerow removal may also have reduced the quantity or quality of shrike habitat (Graber *et al.* 1973). Bull (1974) suggested that shrikes are rare and local over a large portion of northeastern North America because osage orange and thorn trees are scarce. Graber *et al.* (1973) attributed a slow decline in Illinois between 1900 and 1957 to habitat loss. However, the causes of a more rapid decline after this time are unknown. While habitat loss may be partially responsible for shrike decline in some areas, some suitable shrike habitat appears to be vacant (Fraser and Luukkonen 1986, Brooks and Temple 1990a). Cadman (1985) suggested that in the past, when shrikes were more numerous in northeastern America, it is likely that habitat

reduction played an important role in the decline in shrike numbers. There appears to be a general consensus that habitat loss led to the slow reduction in numbers through the middle of the twentieth century in parts of the species' range (Bull 1974, Kridelbaugh 1981). Still, quantitative information about habitat requirements and recent changes in habitat availability is lacking. The presence of apparently suitable habitat in many unoccupied areas and the continued widespread decline of the species would suggest the involvement of other factors.

The degree of tolerance to human disturbance has only been discussed by a few authors and appears to vary considerably. Three studies of Loggerhead Shrikes reported desertion due to human disturbance. One of 77 nests was deserted in Porter *et al.*'s (1975) study, 6 of 37 nests in Seigel's (1980) study and 1 of 60 nests in Kridelbaugh's (1983) study. Tolerance to indirect human disturbance caused by vehicular traffic is variable according to Campbell (1975). In addition, there were variable responses to other activities such as plowing and cattle herding (Campbell 1975). The effect of direct human disturbance on breeding pairs of birds has not been well documented. With the increasing attention the species will receive due to its status as endangered or threatened, this factor may become more important in the future.

Competition with birds possessing similar food and/or habitat requirements such as the American Kestrel (*Falco sparverius*) (Miller 1931, Bent 1950, Roest 1957, Campbell 1975), the Eastern Kingbird (*Tyrannus tyrannus*) (Hartley 1980) and Starling (*Sturnus*

vulgaris) (Cadman 1985) has been suggested to affect shrike numbers. Both kestrels and kingbirds occupy similar habitat and have similar diets to shrikes. Both species not only will inhabit shrike territories but have been seen in aggressive interactions with shrikes. Eastern Kingbirds in particular are very aggressive in their territorial defense. Further study on their impact on shrikes is still needed. Studies involving kestrels and shrikes in apparent competition reported a separation of habitat (Gawlick 1988).

Various authors have found predation to be a major cause of nest failure in shrikes (Kridelbaugh 1983, Porter *et al.* 1975 and Seigel 1980) with nestlings being more susceptible than eggs (Seigel 1980). Raccoons (*Procyon lotor*), Red Squirrels (*Tamiasciurus hudsonicus*), House Cats (*Felis catus*), snakes, Crows (*Corvus spp.*), Magpies (*Pica pica*) and other avian predators are often suspected. While predation in relation to nesting success requires further study, it is not considered to be a major factor in the species' decline (Cadman 1985).

Adverse climatic trends have affected the Red-backed Shrike (*L. collurio*) in Britain (Bibby 1973). Since the two species occupy similar ecological niches, it has been postulated that the Loggerhead Shrike may also be affected by climate (Cadman 1985, Peakall 1962). Other shrike species, in particular *L. senator* in Germany, have shown a susceptibility to continuous rain and cold temperatures. Kridelbaugh (1983) noted that similar conditions caused the loss of 8 of 28 nests under observation in Missouri.

However the bulky, well insulated nests of Loggerhead Shrikes may be an adaption to cold weather especially in the early breeding season (Skowron and Kern 1980). Weather may have a more indirect effect on shrikes in that it reduces the insect populations upon which shrikes so heavily depend. Snow would make the capture of prey more difficult. Bent (1950) found that in Florida, shrikes left an area affected by long periods of cold weather due to a lack of insect prey. The effect of unusual cold or wet weather is not well established and may be more of a complicating factor than a major cause of decline.

A direct relationship has been found between the amount of various pesticides in the environment and the decline of several species of birds. Predatory birds are often at the greatest risk due to biological magnification in the food chain (Erdman 1970, Campbell 1975, Busbee 1977, Anderson and Duzan 1978 and Kridelbaugh 1983). In southern Illinois, Anderson and Duzan (1978) found that shrikes had acquired appreciable levels of DDE residues, a metabolite of DDT, and that eggshell thickness had been affected. However, levels were much lower than those found in larger avian predators. Furthermore, a study by Korschgen (1970) indicated that DDE may be present in agricultural regions, especially when weather conditions favoured retention of pesticides in the soil. Analysis of an egg and the remains of 2 nestling from Ontario in 1974 found high levels of DDT and PCB's in the egg and DDE in both the nestlings and egg (Campbell 1975). Busbee (1977) found that high levels of dieldrin adversely affected shrike behaviour and

survivorship. The rapid decline of the Loggerhead Shrike on the prairies corresponds to treatment of grasshopper outbreaks with dieldrin (Campbell 1975). Grasshoppers make up 30 to 75 % of the diet of Loggerhead Shrikes (Miller 1931) and any reduction in numbers would certainly affect shrike populations. However, Morrison (1979) did not find decreases in eggshell thickness in California or Florida where shrike populations are decreasing. While a correlation has been drawn between accumulation of DDE and eggshell thickness, other studies have found no evidence of enhanced mortality or excessive reproductive failure associated with DDT contamination in the U.S. populations (Graber *et al.* 1973, Anderson and Duzan 1978, Kridelbaugh 1983). Most data on shrike nesting success indicates a high level of success (Miller 1931, Graber *et al.* 1973, Seigel 1980, Kridelbaugh 1982, Luukkonen 1987, Gawlick and Bildstein 1990). Both DDT and dieldrin were banned from use in the early 1970's. While several other species affected are recovering, the decline in shrike populations continues, suggesting that other factors or perhaps even new environmental contaminants are involved.

Collision with automobiles is another possible factor in the decline of the shrike populations. Various authors have presented evidence to this effect (Robertson 1930, Miller 1931, Bull 1974, Campbell 1975 and Craig 1978). However, the full extent of mortality as a result of accidents with automobiles is not fully known. The shrike's habit of using road side utility wires, telephone poles, shrubs, hedgerows and fences which provide good

perches and the open nature of roads allowing easy detection of prey (Campbell 1975) increase the risk of collisions. The habit of shrikes to perch low and drop low when flying from perch to perch (Zimmerman 1955, Campbell 1975) as well as their relatively weak flying skills (Bent 1950) may increase their susceptibility to collisions. Where roadside ditches are grassed and mowed and injured insects are present on roads (Robertson 1930) this may increase the shrike's attraction to roads as foraging sites. As well, Bent (1950) and Smith (1973b) both observed that while a shrike is concentrating on its prey it may be oblivious to oncoming traffic. In addition, migratory birds may be more susceptible due to the number of roads which they must cross during migration (Cadman 1985).

Shrikes are often known as "butcher birds" due to their habit of impaling vertebrate prey on thorns, barbed wire and sharp branches. Historically, shooting and nest destruction of the shrikes due to their predatory behaviour and the misconception that small avian prey comprises part of the shrikes' diet may have adversely affected the population (McIlwraith 1886, Miller 1931 and Campbell 1975). However, shooting and nest destruction is no longer believed to be prevalent (Cadman 1985). As well, shrikes are a migratory bird and are protected from direct persecution by the Migratory Birds Convention Act.

Official Designation:

The Loggerhead Shrike was designated as "threatened " in

Canada in 1986 by the Committee on the Status of Endangered Wildlife in Canada and in 1991 its status was changed to endangered. In November, 1992 it was placed on the list of endangered species in Ontario and both the bird and its habitat now receive protection under the Endangered Species Act in the province. While small, the population of birds found in Ontario represents the greatest concentration of the *migrans* subspecies found in eastern Canada and the United States. A national Canadian recovery team for the Loggerhead Shrike has been established under RENEW (Recovery of Nationally Endangered Wildlife). The goals of the Recovery Team are as follows: preventing of the further decline of the population, establishing a stable or increasing population at 1,000 adult *L. l. excubitorides* in all prairie provinces where the birds are found and establishing a stable or increasing population of 1,000 adult *L. l. migrans* in Ontario and Quebec combined. Before any protection or conservation efforts can be successful, the factors responsible for the continued decline of the species must be understood. Little is known about the population of Loggerhead Shrikes in eastern Canada and it is hoped that with studies such as this, the goals set out by the recovery team can be achieved. Therefore, the aims of this study were:

- a) to characterize on a broad scale the habitat types that are used by Loggerhead Shrikes in Quebec and Eastern Ontario;
- b) to determine on a fine scale the characteristics of habitat that are selected versus those that are not by breeding Loggerhead Shrikes, considering utilization of different

- cover types for foraging and nesting in particular;
- c) to examine whether reproductive success by Loggerhead Shrikes varies from one habitat type to another;
- d) to obtain basic information about Loggerhead Shrike breeding biology.

LITERATURE CITED

- Anderson, D.W. and R.E. Duzan. 1978. DDE residues and eggshell thinning in Loggerhead Shrikes. *Wilson Bull.* 90:215-220.
- Applegate, R.D. 1977. Possible ecological role of food caches of Loggerhead Shrikes. *Auk* 94:391-392.
- Arbib, R. 1977. Blue List 1978. *Am. Birds* 31:1093-1094.
- Atkinson, W.L. 1901. Nesting habits of the California shrike *Lanius ludovicianus gambeli* Ridgw. *Condor* 3:9-11.
- Balda, R.P. 1965. Loggerhead Shrike kills mourning dove. *Condor* 67:359.
- Beal, F.E. L. and W.L. McAtee. 1912. Food of some well-known birds of forest, farm, and garden. U.S. Dept. Agric. Farmer's Bull. No. 506.
- Bent, A.C. 1950. Life histories of North American wagtails, shrikes, vireos and their allies. U.S. Natl. Mus. Bull. 197:114-182.
- Bibby, C. 1973. The red-backed shrike: A vanishing British species. *Bird Study* 20:103-110.
- Brooks, B.L. and S.A. Temple. 1990a. Habitat availability and suitability for Loggerhead Shrikes in the Upper Midwest. *Am. Midl. Nat.* 123:75-83.

- Brooks, B.L. and S.A. Temple. 1990b. Dynamics of a Loggerhead Shrike population in Minnesota. *Wilson Bull.* 102:441-450.
- Bull, J. 1974. *Birds of New York State*. Doubleday Natural History Press, New York.
- Busbee, E.L. 1976. The ontogeny of cricket killing and mouse killing in Loggerhead Shrikes (*Lanius ludovicianus* L.). *Condor* 78:357-365.
- Busbee, E.L. 1977. The effects of dieldrin on the behaviour of young Loggerhead Shrikes. *Auk* 94:28-35.
- Cadman, M.D. 1985. Status report on the Loggerhead Shrike (*Lanius ludovicianus*) in Canada. Draft report for the Committee on the Status of Endangered Wildlife in Canada.
- Campbell, C. 1975. Distribution and breeding success of the Loggerhead Shrike in southern Ontario. *Can. Wildl. Serv., Report No. 6055*, unpublished report.
- Cely, J.E. and Z. Corontzes. 1986. Loggerhead Shrike investigations annual progress report., 1986. S.C. Wildlife and Marine Resources Department, Nongame-Heritage Trust Program, unpublished report.
- Chapman B.R. and S.D. Casto. 1972. Additional vertebrate prey of the Loggerhead Shrike. *Wilson Bull.* 84:496-497.
- Craig, R.B. 1978. An analysis of the predatory behaviour of the Loggerhead Shrike. *Auk* 95:221-234.
- Ellison, L.N. 1971. Spruce grouse attacked by a northern shrike. *Wilson Bull.* 83:99-100.
- Erdman, T.C. 1970. Current migrant shrike status in Wisconsin.

- Passenger Pigeon. 35:144-150.
- Forbush, E.H. 1939. Natural history of the birds of eastern and central North America. Revised by J.B. May (1943). Houghton Mifflin, Boston, Mass.
- Fraser, J.D. and D.R. Luukkonen. 1986. The Loggerhead Shrike. Pages 933-941 *in* Audubon Wildlife Report 1986. National Audubon Society, New York, New York.
- Gawlick, D.E. 1988. Reproductive success and nesting habitat of Loggerhead Shrikes and relative abundance, habitat use and perch use of Loggerhead Shrikes and American Kestrels in South Carolina. M.Sc. thesis. Winthrop College, Rock Hill, South Carolina.
- Gawlick, D.E. and K.L. Bildstein. 1990. Reproductive success and nesting habitat of Loggerhead shrikes in North-Central South Carolina. *Wilson Bull.* 101:37-48.
- Geissler, P.H. and B.R. Noon. 1981. Estimates of avian population trends from the North American breeding bird survey. Pages 42-51 *in* Estimating the numbers of terrestrial birds, C.J. Ralph and M.Scott (eds). *Studies in Avian Biology* Vol. 6.
- Godfrey, W.E. 1986. The birds of Canada. National Museum of Natural Science, Ottawa, Ont..
- Graber, R.R., J.W. Graber and E.L. Kirk. 1973. Illinois birds: Laniidae. *Biol. Ser. No. 83*. State of Illinois.
- Haas, C.A. and S.A. Sloan. 1989. Low return of migratory loggerhead shrikes: winter mortality or low site fidelity. *Wilson*

- Bull. 101:458-460.
- Hartley, R. 1980. Shrike strike. Blue Heron 24:13-14.
- Judd, S.D. 1898. The food of shrikes. U.S. Dept. of Agr. Bull. No. 9. Govt. Print. Off. Washington. 9:15-26.
- Knowlton, G.F. and F.C. Harmston. 1944. Food of the white-rumped shrikes. Auk 61:642-643.
- Korschgen, L.J. 1970. Soil-food-chain-pesticide wildlife relationships in aldrin-treated fields. J. Wildl. Manage. 34:186-199.
- Kridelbaugh, A. 1981. Population trend, breeding and wintering distribution of loggerhead shrikes (*Lanius ludovicianus*) in Missouri. Trans. Miss. Acad. Sci. 15:111-119.
- Kridelbaugh, A.L. 1982. An ecological study of Loggerhead Shrikes in central Missouri. M. Sc. Thesis. Univ. of Missouri, Columbia, Missouri.
- Kridelbaugh, A. 1983. Nesting ecology of the Loggerhead Shrike in central Missouri. Wilson. Bull. 95:303-308.
- Lohrer, F.E. 1974. Post-hatching growth and development of the Loggerhead Shrike in Florida. M. Sc. thesis, Univ. South Florida, Tampa.
- Luukkonen, D.R. 1987. Status and breeding ecology of the loggerhead shrike in Virginia. M.Sc. thesis. Virginia Polytechnic Institute and State University, Blacksburg, Virginia.
- Mayfield, H. 1949. Nesting season. Middlewestern prairie region. Aud. Field Notes 3:237-238, 240.
- McIlwraith, T. 1886. The birds of Ontario. A. Lawson & Co.,

Hamilton.

- Miller, A.H. 1931. Systematic revision and natural history of the American shrikes (*Lanius*). Univ. Calif. Publ. in Zool. 38:11-242. University of California Press, Berkeley.
- Mills, G.S. 1979. Foraging patterns of kestrels and shrikes and their relation to an optimal foraging model. Unpubl. Ph.D. dissertation, Univ. Arizona.
- Morrison, M.L. 1979. Loggerhead Shrike (*Lanius ludovicianus*) egg shell thickness in California and Florida. Wilson Bull. 91:468-469.
- Morrison, M.L. 1980. Seasonal aspects of the predatory behaviour of Loggerhead Shrikes. Condor 82:296-300.
- Morrison, M.L. 1981. Population trends of the Loggerhead Shrike in the United States. Am. Birds 35:754-757.
- Peakall, D.B. 1962. The past and present status of the red-backed shrike in Great Britain. Bird Study 9:198-216.
- Peterson, P.C. 1965. Spring migration. Middlewestern prairie region. Aud. Field Notes 19:480-482.
- Pittaway, R. 1993. Double-brooding in Ontario Loggerhead Shrikes. Ont. Birds. 11:69-70.
- Porter, D.K., M.S. Strong, J.B. Giezantanner and R.A. Ryder. 1975. Nest ecology, productivity and growth of the Loggerhead Shrike on the short grass prairie. Southwest Nat. 19:429-436.
- Prescott, D.R. and D.M. Collister. 1993. Characteristics of occupied and unoccupied Loggerhead Shrike territories in

- southeastern Alberta. J. Wildl. Manage. 57:346-352.
- Raikow, R.J., P.J. Polumbo, and S.R. Boregky. 1980. Appendicular myology and relationships of the shrikes (Aves: Passeriformes: Laniidae). Ann. Carnegie Mus. 49:131-152.
- Rand, A.L. 1960. Family Laniidae. In Check-list of birds of the world (E. Mayr and J.C. Greenway, Jr., eds.). Mus. Comp. Zool., Cambridge, Mass. 9:1-506.
- Robert, M. 1989. Les oiseaux menaces du Quebec. Environment Canada. Canadian Wildlife Service. Quebec, Que.
- Robertson, J.M. 1930. Roads and birds. Condor 32:142-146.
- Roest, A.I. 1957. Notes on the American sparrow hawk. Auk 74:1-19.
- Salt, G.W. 1967. Predation in an experimental protozoan population (*Woodruffia-Paramecium*). Ecol. Monogr. 37:113-144.
- Seigel, M.S. 1980. The nesting ecology and population dynamics of the Loggerhead Shrike in the blackbelt of Alabama. M.Sc. thesis, Univ. Alabama, Birmingham, Alabama.
- Skowron, C. and M.Kern. 1980. The insulation in nests of selected North American songbirds. Auk 97:816-824.
- Smith, S.M. 1973a. An aggressive display and related behaviour in the Loggerhead Shrike. Auk 90:287-298.
- Smith, S.M. 1973b. A study of prey-attack behaviour in young Loggerhead Shrikes, *Lanius ludovicianus* L. Behaviour 44:113-141.
- Smith, E.L. and K.C. Kruse. 1992. The relationship between land-use and the distribution and abundance of loggerhead shrikes in South-Central Illinois. J. Field Ornithol., 63:420-

427.

- Telfer, E.S. 1992. Habitat change as a factor in the decline of the western Canadian Loggerhead Shrike, *Lanius ludovicianus*, population. Can. Field. Nat. 106:321-326.
- Tracy, H.C. 1910. Significance of white markings in birds of the order Passeriformes. Univ. Calif. Publ. Zool. 6:285-312.
- Tyler, J.D. 1992. Nesting ecology of the Loggerhead Shrike in southwestern Oklahoma. Wilson Bull. 104:95-104.
- Watson, J.R. 1910. The impaling instinct in shrikes. Auk 27:459.
- Wemmer, C. 1969. Impaling behaviour of the Loggerhead Shrike, *Lanius ludovicianus* Linnaeus. A. F. Tierpsychol. 26:208-224.
- Yosef, R. and B. Pinshaw. 1989. Cache size in shrikes influences female mate choice and reproductive success. Auk 106:418-421.
- Zimmerman, D.A. 1955. Notes on field identification and comparative behaviour of shrikes in winter. Wilson Bull. 67:200-208.

Connecting Statement

The first step in the successful conservation of a species is to understand population size and distribution of the species in order to conserve both habitat and species. Section 2 deals with the population distribution and trends of the Loggerhead Shrike in Ontario, in an attempt to understand the pattern of decline experienced by this species.

SECTION 2:
POPULATION DISTRIBUTION AND TRENDS OF THE LOGGERHEAD SHRIKE
IN ONTARIO AND QUEBEC

A.A. Chabot, D.M. Bird, R.D. Titman and D.G. Cuddy

ABSTRACT

The status and distribution of the Loggerhead Shrike (*Lanius ludovicianus migrans*) in southern Ontario and Quebec was studied during the 1991 and 1992 breeding seasons. The *Ontario Breeding Bird Atlas* reported that 57 10 x 10 km squares had probable or confirmed evidence of breeding Loggerhead Shrikes during the 5 year period of 1981-1985. Forty six 10 x 10 km squares were located in association with the 3 limestone plains or core areas in the southern portion of the province (Carden plain, Napanee plain and Smith's Falls plain) and the Grey-Bruce counties area. Totals of 18 10 x 10 km squares in 1991 and 28 10 x 10 km squares in 1992 were found to have confirmed evidence of breeding Loggerhead Shrikes. Thirty breeding pairs were located in 1991 and 57 in 1992. The increased number of pairs is a result of augmented effort put into searching all squares with probable or confirmed evidence of breeding. One breeding pair was located in the province of Quebec in 1991 and two in 1992. The suitability and reoccupancy rate of historic sites in the 3 core areas of Ontario was assessed. Seventy four (54%) of the sites were found to be suitable but unoccupied while 62 (46%) were judged no longer suitable. The reoccupancy rate of suitable historic sites was 30% while 16% of all historic sites were reoccupied. The reoccupancy rate of breeding sites located in 1991 ranged from 67%, 75% and 86% on the Carden plain, the Smith's Falls plain and the Napanee plain, respectively, for an overall average of 76%.

Introduction

The Loggerhead Shrike (*Lanius ludovicianus*) has a widespread distribution throughout North America with 3 of 11 subspecies being found in Canada (Godfrey 1986). The eastern subspecies of the Loggerhead Shrike (*Lanius ludovicianus migrans*) was first recorded in eastern Canada in 1860 (McIlwraith 1886). Its range expanded north and east into the middle of the 20th century with the clearing of land for agricultural purposes and settlement (Forbush 1939). However, its range has been gradually contracting since the mid-1940's. Although once a relatively common breeder, the species is virtually extirpated in Manitoba and Quebec, while in Ontario the population has experienced greatest losses from the northern and southern portions of its range (Cadman 1985). In 1991, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the Loggerhead Shrike as "endangered". Significant decreases have been noted throughout much of the rest of the species' former range as well (Peterson 1965, Erdman 1970, Geissler and Noon 1981, Morrison 1981, Cadman 1985). The Loggerhead Shrike has been on the Blue List of threatened species in the United States since its inception in 1971 (Tate 1986). Several factors have been identified as being of possible importance in explaining the species' decline including competition with other avian species (Campbell 1975, Hartley 1980, Cadman 1985), predation (Porter et al. 1975, Seigel 1980, Kridelbaugh 1983), adverse climatic trends (Peakall 1962, Bibby 1973), environmental contamination (Erdman 1970, Campbell 1975, Busbee 1977, Anderson and Duzan 1978,

Kridelbaugh 1983), collisions with automobiles (Miller 1931, Bull 1974, Campbell 1975, Craig 1978), shooting and nest destruction (McIlwraith 1886, Campbell 1975) and habitat loss (Graber *et al.* 1973, Bull 1974, Campbell 1975, Kridelbaugh 1981, Smith and Kruse 1992, Prescott and Collister 1993). While small in numbers, the population in Ontario now represents the stronghold for the eastern subspecies in Canada. Data from 1981 through 1985, as provided in the Atlas of the Breeding Birds of Ontario (Cadman *et al.* 1987) and from the Ontario Rare Breeding Bird Program from 1987 through 1990, indicated that the breeding range of the species was restricted to southern Ontario. The actual number of breeding pairs could only be postulated due to the nature of these surveys. Therefore, a study was conducted in 1991 and 1992 in order to determine the status and distribution of the Loggerhead Shrike in southeastern Ontario.

Study Area

This study was conducted during the breeding seasons of 1991 and 1992 in three core areas of Loggerhead Shrike breeding concentration in southeastern Ontario. The easternmost area was associated with the Smith's Falls limestone plain to the south and west of Ottawa, Ontario. The second area was situated on the Napanee plain to the west of Kingston, Ontario. The third and most western area was associated with the Carden plain to the north of Lindsay, Ontario. All three regions are located in south-central Ontario between the edge of the Canadian Shield and Lake Ontario. The Carden plain is an area of 583 square km of limestone plain

with very little overburden (Chapman and Putnam 1984). Named for Carden Township which occupies the central part of the area, the physical conditions are similar to those of the Napanee and Smith's Falls plains farther east, however, there are certain differences. Table 1.1 describes the typical plant species within the 3 limestone plains. The 1981 agricultural census for Carden township gave the average farm size as 200 ha, 15% of which was improved land, 3% was seeded in pasture, 11% was in crops and 10 % as woodland. Rough pasture accounted for more than 70% of the land (Chapman and Putnam 1984). While the dairy industry accounts for a large proportion of the land use in the Napanee and Smith's Falls plains, the land on the Carden plain is used mostly for beef cattle.

The Napanee plain is a flat to undulating plain of limestone from which the last glaciation stripped most of the overburden (Chapman and Putnam 1984). Centering on the town of Napanee, it covers approximately 1813 km. In 1981 the average farm comprised 85 ha in size and had about 10% of its land in woods, 18% in other unimproved land and about 60% devoted to crops of which hay (23%) and corn (*Zea mays*) (21%) were the most prevalent, with barley (*Hordeum vulgare*), wheat (*Triticum aestivum*), oats (*Avena sativa*) and mixed grains together occupying less than 15% of the farmland. Cultivated and rough permanent pasture occupied 26% of the farmland and grazing was very extensive. Roughly 47% of the commercial farms in 1981 were dairy farms while 53% depended mainly on beef cattle. However, beef cattle had increased, while the population

of dairy cows had decreased (Chapman and Putman 1984). The Smith's Falls plain is the largest and most continuous tract of shallow soil over limestone in southern Ontario and covers nearly 3626 square km in the united Counties of Leeds and Grenville, the Regional Municipality of Ottawa-Carleton, and Lanark County. Slightly over 80% of the land was occupied by farms in 1981 which averaged about 95 ha in size. Only about half of the land was improved and one third was in crop, consisting mainly of hay, corn, oats, mixed grains and barley. The large area of unimproved pastureland is in accordance with the extensive dairy farming occurring in the 1970's (Chapman and Putnam 1984).

Methods

In 1991 a survey of all known breeding sites from the 2 year volunteer Loggerhead Shrike Survey (1987-1989) was made in each of the 3 core areas. Individuals familiar with the location of Loggerhead Shrikes were contacted and asked to help in locating breeding pairs. In addition, 4 individuals were hired by the Ontario Ministry of Natural Resources in the Napanee region to survey the surrounding area and locate Loggerhead Shrike territories.

In 1992 a more in-depth survey was made in order to locate and document all active shrike territories in Ontario. All sites at which shrikes were known to have nested during the Ontario Rare Breeding Bird Program period (1987-1989) and all Ontario Breeding Bird Atlas squares in eastern Ontario which had confirmed or probable breeding records during the atlas period (1981-1985) were

surveyed. "Possible" evidence of breeding included the following: species observed in its breeding season in suitable nesting habitat; single male(s) present or breeding calls heard in suitable nesting habitat in breeding season. "Probable" evidence was indicated by one of the following observations: pair observed in suitable nesting habitat in nesting season; permanent territory presumed through registration of territorial behaviour (song etc.) on at least two days, a week or more apart, at the same place; courtship or display, including interaction between a male and a female or two males, courtship feeding or copulation; agitated behaviour or anxiety calls of adults; brood patch on adult female or cloacal protuberance on adult male. In order for breeding to be characterized as "confirmed" the observer must have seen one of the following: used nest or egg shells found, recently fledged young; adults leaving or entering nest sites in circumstances indicating occupied nest; adult carrying fecal sac or food for young; nest containing eggs; nest with young seen or heard. Only the highest level of breeding evidence and the highest category observed within that level was recorded for each species (Cadman *et al.* 1987).

The data collection units for the Ontario Breeding Bird Atlas project were based upon the Universal Transverse Mercator (UTM) grid system. Because the majority of Ontarians live in the southern part of the province, and because access to much of the northern portion of the province is difficult, it was not feasible to collect data on the same grid scale throughout the province. Therefore, southern Ontario was surveyed and mapped by smaller 10

by 10 km units, often referred to as squares. Northern Ontario was atlassed by larger 100 by 100 km units referred to as blocks.

A coordinator was hired by the OMNR to contact and organize volunteer efforts and to intensively survey core habitat areas in the Napanee plain and the southern part of the Smith's Falls plain. All surveyors were familiar with the basic physical characteristics of the Loggerhead Shrike, either through previous personal observation or through familiarization from photographs or illustrations. About 40 volunteers, recruited from the ranks of local naturalist clubs, assisted in surveying a total of 65 breeding bird Atlas squares in 1992.

All surveyors were assigned one or more 10 by 10 km squares to survey. Once in their square, surveyors sought out areas of suitable shrike habitat by driving the roads within each square. While driving through suitable habitat, surveyors proceeded at not more than 10-20 km/h, continually checking the tops of bushes, trees and utility wires for shrikes. When in suitable habitat surveyors stopped their cars about every 200-300 m and scanned the surrounding countryside for shrikes. Stops lasted at least 8 to 10 minutes to give the observer adequate time to determine the apparent presence or absence of shrikes. Surveyors then proceeded in similar fashion through the remainder of suitable quality habitat. Surveyors had at their disposal the appropriate survey forms, a pair of binoculars and/or telescope, a field guide to birds, a road map and topographic map coverage of the area. Once a shrike was sighted, the surveyor noted the location using UTM

coordinates on the appropriate 1:50,000 topographic map or square map and watched the bird(s) as closely as possible to determine if in fact there was evidence of breeding as indicated by nest building, feeding of the mate on the nest or feeding of nestlings. They then completed the Ontario Rare Breeding Bird Program Survey Report Form and upon completion of the surveys all information and forms were returned to the local shrike survey coordinator or to the appropriate OMNR employee. Surveyors were asked to keep all records of their surveys confidential. An OMNR employee familiar with Loggerhead Shrikes and a research assistant from McGill University surveyed the Carden plain and the senior author helped with surveying the Napanee and Smith's Falls plains. As well, several observations were independently conveyed to the Rare Breeding Bird Program or the OMNR by birdwatchers.

The high rate of site reuse experienced in Ontario led to the examination of the Ontario Breeding Bird Atlas and rare breeding bird program sightings to determine how many historic sites were reoccupied as well (Table 1.5). The suitability of historic sites was determined by site checks and the reoccupancy rate of suitable sites and total sites in an area were calculated. The reoccupancy rate for the Napanee plain may have been overestimated because a local naturalist group, fearing public exposure of sites, chose not to report their sightings.

Results

During the Ontario Breeding Bird Atlas period from 1981 through 1985, Loggerhead Shrikes were reported in 145 (8%) of 1824

squares in southern Ontario. Of the 145 squares, 60 were deemed to have possible evidence of breeding, 28 squares were listed as probable and 57 had confirmed evidence of breeding (Cadman *et al.* 1987) (Fig. 1.1). Forty six of the 57 squares were located in either the Grey-Bruce counties, Carden plain, Napanee plain or Smith's Falls plain areas (Table 1.2). In 1991, a total of 18 Ontario Breeding Bird Atlas squares were found to have confirmed evidence of breeding Loggerhead Shrikes (Fig. 1.2). Five of these were located in the Carden plain area, 8 in the Napanee plain and 5 on the Smith's Falls plain. Of the 65 squares searched in 1992, a total of 28 were found to have confirmed evidence of breeding (Fig. 1.3). There was a 50% decline in 1991 and 30% decline in 1992 in the number of squares with confirmed evidence of breeding from 1981 to 1985 for the Carden plain area. In the Napanee plain the decline was only 33% in 1991 and 25% in 1992 from the period of 1981 to 1985, while the Smith's Falls plain area suffered the greatest decline; only 74% and 42% of the squares occupied from 1981 to 1985 were found to have breeding pairs in 1991 and 1992, respectively. The rates of decline for 1992 are more accurate due to the intensive efforts put into searching squares and historic sightings and therefore the decline rates of 1991 should be regarded as inflated.

The search of known nesting sites in 1991 resulted in a total of 28 pairs of breeding Loggerhead Shrikes and 3 individuals being found in southern Ontario in addition to 1 pair located in the province of Quebec. The intensive search of known nesting sites

and suitable shrike habitat in 1992 located a total of 54 breeding pairs and 11 individual birds. Individual sightings were not believed to be significant as the birds may have later been seen on breeding territories. As well, 2 pairs were located in Quebec in 1992 (Table 1.3). In 1991, 48% of all the breeding pairs and over half (31 pairs or 56%) of the total pairs in 1992 were located in the Napanee plain region. The remaining pairs in 1991 were evenly divided between the Carden plain (7 pairs or 24%) and the Smith's Falls plain (8 pairs or 28%). In 1992, more effort was put into searching the larger Smith's Falls plain area and the number of pairs found increased to 14 (26%). The number of birds in the immediate Carden area stayed relatively the same, however, a few birds were reported in outlying areas, increasing the total number of pairs in this area to 9 (16%). In addition, one pair was located in the Grey-Bruce counties area in 1992.

Efforts in locating birds in 1992 were aided by the fact that many territories used in 1991 were reoccupied in 1992 (Table 1.4). The reoccupancy rate in the three core areas in southern Ontario ranged from 67% to 86% for an average of 76%. In Quebec, the one site having a breeding pair of Loggerhead Shrikes was also reoccupied in 1992. The proportion of historic sites which were still suitable ranged from 30% to 93% for the 4 areas. The Carden plain was the only area where the number of suitable historic sites was greater than the number of unsuitable sites. The rate of reoccupancy of suitable sites ranged from 0% to 75%. However, the reoccupancy rate somewhat paralleled the proportion of active

territories located in each of the 3 areas with the Napanee plain having the greatest site reoccupancy, followed by the Smith's Falls plain, the Carden plain and the Grey-Bruce county area. It is interesting to note that more than one fourth (26%) of all active territories in 1991 and 1992 were located at historic sites.

Discussion

The Loggerhead Shrike experienced an expansion of its range into the middle of the twentieth century followed by a steady decline in numbers over the past 40 years with the greatest decline occurring since the late 1960's (Cadman 1985, Hanrahan 1987). Data summarized in the *Atlas of Breeding Birds of Ontario* (Cadman *et al.* 1987) indicate that the breeding range of the species was essentially restricted to southern Ontario during the atlas period of 1981-1985 and showed a strong association with the 3 limestone plains in southern Ontario. Abundance estimates during this period suggested a total population of between 50 and 100 pairs per year, with the number declining during the atlas period. The data from the present study indicate that this decline has continued, with just over 50 pairs being found in all of southern Ontario. Only 61% of the squares that had confirmed evidence of breeding during the atlas period still sustained breeding pairs of Loggerhead Shrikes. As well, the population's range seems to have contracted further into the 3 core areas.

In recent history a number of changes have occurred in the use of rural lands in southern Ontario. In his 1990 report, Cadman (1985) cited Statistics Canada figures which reported a 65% decline

in the area of pasture in Ontario during the period of 1921-1986. Statistics Canada figures showed that much of this loss occurred between 1966-1986, the period during which Cadman believed the greatest decline in shrike numbers had occurred. Telfer (1992) reported that regions of Alberta and Saskatchewan showing large declines in populations of breeding Loggerhead Shrikes in recent decades lost 39% of their unimproved pasture area through conversion to cropland between 1946 and 1986 and up to 79% of their pre-settlement pasture area. However, regions where shrikes declined less lost only 12% of their unimproved pasture but had probably lost 65% of their pre-settlement pasture area. He added that in probable shrike winter range in Texas, pasture had also declined due to encroachment by cropland and brush invasion. Smith and Kruse (1992) suggested that land-use practices influenced the distribution and abundance of the Loggerhead Shrike in Illinois. While Cuddy (1993) pointed out that census figures do not account for the effect of fragmentation of habitat, it would appear that habitat loss has played a part in the decline of the species in some areas. The impact of agriculture on the environment rises directly with the increases in the percentage of improved land. The 1976 census of agriculture showed a 40 to 60% increase in the percentage of improved land on occupied farm land in southern Ontario (Fig. 1.4) (Cadman *et al.* 1987). Much suitable habitat does still exist and many sites where Loggerhead Shrikes once nested are now unoccupied (Cadman 1985), indicating that other factors are involved in the continued steady decline of the species in Ontario.

The high degree of territory reoccupancy exhibited by the Loggerhead Shrike in southern Ontario differs from the findings of Haas and Sloan (1989) who found that only 14% of adult Loggerhead Shrikes banded during a 4 year period were resighted, a figure much lower than return rates usually reported for site faithful birds. Other studies with unmarked Loggerhead Shrikes found a high degree of site re-use which may have mistakenly been taken to indicate a high degree of site fidelity (Atkinson 1901, Miller 1931, Bent 1950, Campbell 1975, Porter *et al.* 1975 and Kridelbaugh 1983). However, there does appear to be a high degree of site reoccupancy by Loggerhead Shrikes throughout their range which is in accord with the findings of this study. Furthermore, the degree of territory reoccupancy experienced in this study (76%) is well above Kridelbaugh's (1983) estimated 54% reoccupancy rate.

Research concerned with characteristics of the occupied sites will increase the understanding of the characteristics of a breeding site which are important to breeding Loggerhead Shrikes. The differential success in locating shrikes at recent and historic sightings coupled with the inactivity at 74% of the suitable sites may indicate mortality or abandonment and movement to new breeding territories. Very little quantitative information exists concerning the effects of predation, interspecific competition, road kills, climatic changes and environmental contamination, all of which may be responsible at least in part for the decline of the species (Cadman 1985). Further study into these factors is necessary before conservation measures can adequately respond to

the declining populations. Presently, habitat both in and around active and historic nesting sites should be protected from further changes. In addition, habitat restoration, especially at historic sites, is required as shrikes have been known to return to a site after a period of disuse up to 5 years (M. Cadman pers. comm.). The three core areas of habitat associated with the limestone plains in southeastern Ontario harbor the majority of the population of migrant shrikes in eastern Canada and therefore protection of habitat in these areas is essential.

Literature Cited

- Anderson, D.W. and R.E. Duzan. 1978. DDE residues and eggshell thinning in Loggerhead Shrikes. *Wilson Bull.* 90:215-220.
- Atkinson, W., L. 1901. Nesting habits of the California shrike *Lanius ludovicianus gambeli* Ridgw. *Condor* 3:9-11.
- Bent, A.C. 1950. Life histories of North American Wagtails, shrikes, vireos and their allies. U.S. Natl. Mus. Bull. 197:114-182.
- Bibby, C. 1973. The red-backed shrike: A vanishing British species. *Bird Study* 20:103-110.
- Bull, J. 1974. Birds of New York State. Doubleday Natural History Press, New York.
- Busbee, E.L. 1977. The effects of dieldrin on the behaviour of young Loggerhead Shrikes. *Auk* 94:28-35.
- Cadman, M.D. 1985. Status report on the Loggerhead Shrike (*Lanius ludovicianus*) in Canada. Draft report for the Committee on the Status of Endangered Wildlife in Canada.

- Cadman, M.D., P.F.J. Eagles, F.M. Eagles and F.M. Helleiner. 1987. Atlas of Breeding Birds of Ontario. University of Waterloo Press.
- Campbell, C. 1975. Distribution and breeding success of the Loggerhead Shrike in southern Ontario. Can. Wildl. Serv., Report No. 6055, unpublished report.
- Cely, J.E. and Z. Corontzes. 1986. Loggerhead Shrike investigations annual progress report., 1986. S.C. Wildlife and Marine Resources Department, Nongame-Heritage Trust Program, unpublished report.
- Chapman, L.J. and D.F. Putnam. 1984. The physiography of Ontario. Ontario Geological Survey, Special Vol. 2.
- Craig, R.B. 1978. An analysis of the predatory behaviour of the Loggerhead Shrike. Auk 95:221-234.
- Cuddy, D. 1993. Protection and Restoration of Breeding Habitat for the Loggerhead Shrike (*Lanius ludovicianus*) in Ontario, Canada. In The Proceedings of the First International Shrike Symposium, Lake Placid, Florida. In press.
- Cuddy, D.G. 1994. Vascular plants of eastern Ontario. In press. Ministry of Natural Resources.
- Erdman, T.C. 1970. Current migrant shrike status in Wisconsin. Passenger Pigeon. 35:144-150.
- Forbush, E.H. 1939. Natural history of the birds of eastern and central North America. Revised by J.B. May (1943). Houghton Mifflin, Boston, Mass.
- Geissler, P.H. and B.R. Noon. 1981. Estimates of avian population

- trends from the North American breeding bird survey.
Pages 42-51 in Estimating the numbers of terrestrial
birds, C.J. Ralph and M. Scott (eds). Studies in Avian
Biology Vol. 6.
- Godfrey, W.E. 1986. The birds of Canada. National Museum of Natural
Science, Ottawa, Ont.
- Graber, R.R., J.W. Graber and E.L. Kirk. 1973. Illinois birds:
Laniidae. Biol. Ser. No. 83. State of Illinois.
- Haas, C.A. and S.A. Sloan. 1989. Low return of migratory loggerhead
shrikes: winter mortality or low site fidelity. Wilson
Bull. 101:458-460.
- Hanrahan, C., 1987. The Loggerhead Shrike: Status report for the
Ottawa District. Trail & Landscape 21:154-168.
- Hartley, R. 1980. Shrike strike. Blue Heron 24:13-14.
- Kridelbaugh, A. 1981. Population trends, breeding and wintering
distribution of loggerhead shrikes (*Lanius ludovicianus*)
in Missouri. Trans. Miss. Acad. Sci. 15:111-119.
- Kridelbaugh, A. 1983. Nesting ecology of the Loggerhead Shrike in
central Missouri. Wilson Bull. 95:303-308.
- McIlwraith, T. 1886. The birds of Ontario. A. Lawson & Co.,
Hamilton.
- Miller, A.H. 1931. Systematic revision and natural history of the
American shrikes (*Lanius*). Univ. Calif. Publ. in Zool.
38(2):11-242. University of California Press, Berkeley.
- Morrison, M.L. 1981. Population trends of the Loggerhead Shrike in
the United States. Am. Birds 35:754-757.

- Peakall, D.B. 1962. The past and present status of the red-backed shrike in Great Britain. *Bird Study* 9:198-216.
- Peterson, P.C. 1965. Spring migration. Middlewestern prairie region. *Aud. Field Notes* 19:480-482.
- Porter, D.K., M.S. Strong, J.B. Geizentanner and R.A. Ryder. 1975. Nest ecology, productivity and growth of the Loggerhead Shrike on the short grass prairie. *Southwest Nat.* 19:429-436.
- Prescott, D.R. and D.M. Collister. 1993. Characteristics of occupied and unoccupied Loggerhead Shrike territories in southeastern Alberta. *J. Wildl. Manage.* 57:346-352.
- Seigel, M.S. 1980. The nesting ecology and population dynamics of the Loggerhead Shrike in the blackbelt of Alabama. M.Sc. thesis, Univ. Alabama, Birmingham, Alabama.
- Smith, E.L. and K.C. Kruse. 1992. The relationship between land-use and the distribution and abundance of loggerhead shrikes in South-central Illinois. *J. Field Ornithol.*, 63:420-427.
- Tate, J. Jr. 1986. The blue list for 1986. *Am. Birds* 40:227-236.
- Telfer, E.S. 1992. Habitat change as a factor in the decline of the western Canadian Loggerhead Shrike, *Lanius ludovicianus*, population. *Can. Field. Nat.* 106:321-326.
- Telfer, E.S., C. Adams, K. DeSmet and R. Wershler. 1989. Status of Distribution of the Loggerhead Shrike in western Canada. *Can. Wildlf. Serv. Rep.* unpublished.

Table 1.1. Typical plant species found in Loggerhead Shrike habitats in southern Ontario (Cuddy 1994).

Scientific name	Common name
TREES	
<i>Pyrus malus</i>	Apple
<i>Ulmus americana</i>	American (white) elm
<i>Quercu macrocarpa</i>	Burr oak
<i>Fraxinus americana</i>	White ash
<i>Fraxinus pennsylvanica</i>	Red ash
<i>Fraxinus pennsylvanica</i> var. <i>subintegerrima</i>	Green ash(2)
SHRUBS (INCLUDING SMALL TREES)	
<i>Crataegus</i> sp.	Hawthorn(3)
<i>Pyrus malus</i>	Apple
<i>Juniperus virginianus</i>	Eastern red cedar(1)
<i>Thuja occidentalis</i>	Eastern white cedar(2)
<i>Rhamnus catharticus</i>	Common buckthorn
<i>Prunus nigra</i>	Canada plum
<i>Prunus virginiana</i>	Choke cherry
<i>Prunus pennsylvanica</i>	Pin cherry
<i>Xanthoxylum americanum</i>	Prickly ash
<i>Rubus strojosus</i>	Red raspberry
<i>Rubus occidentalis</i>	Black raspberry
<i>Rubus allegheniensis</i>	Common blackberry
<i>Rhus typhina</i>	Staghorn sumac
<i>Rhus radicans</i>	Poison ivy
<i>Celastrus scandens</i>	Climbing bittersweet
<i>Ribes</i> sp.	Gooseberry/Current
HERBACEOUS SPECIES	
<i>Poa pratensis</i>	Kentucky bluegrass
<i>Poa compressa</i>	Canada bluegrass
<i>Panicum</i> sp.	Panic grass
<i>Sporobolus</i> sp.	Dropseed grasses
<i>Phleum pratense</i>	Timothy
<i>Carex</i> sp.	Sedges
<i>Solidago nemoralis</i>	Goldenrod
<i>Daucus carota</i>	Wild carrot/Queen Anne's lace
<i>Chrysanthemum leucanthemum</i>	Ox-eye daisy

Table 1.1 cont'd. Typical plant species found in Loggerhead
Shrike habitats in southern Ontario (Cuddy
1994).

Scientific name	Common name
HERBACEOUS SPECIES	
<i>Hypericum perforatum</i>	Common St. John's-wort
<i>Melilotus</i> sp.	Sweet clovers
<i>Potentilla</i> sp.	Cinquefoils
<i>Fragaria virginiana</i>	Common strawberry
<i>Hieraceum</i> sp.	Hawkweeds
<i>Dianthonia spicata</i>	Poverty grass
<i>Eleocharis</i> sp.	Spike-rush
<i>Origanum vulgare</i>	Wild oregano(2)
LICHENS AND MOSSES	
<i>Cladonia</i> sp.	Fruticose lichens
	Various mosses

-
- (1) Largely restricted to (most common in) Napanee area
 - (2) Largely restricted to (most common in) Smith Falls area
 - (3) Uncommon in Napanee area

Table 1.2. Number of 10 by 10 km Ontario Breeding Bird Atlas squares with confirmed evidence of breeding Loggerhead Shrikes in southern Ontario from 1981-1985 (Cadman *et al.* 1987), 1991 and 1992.

Core Area	1981-1985	1991	1992
Grey-Bruce Counties	2	0	1
Carden Plain	10	5	7
Napanee Plain	12	8	9
Smith's Falls Plain	19	5	11
Total	43	18	28

Table 1.3. Number of breeding pairs of Loggerhead Shrikes in southern Ontario and Quebec in 1991 and 1992.

Core area	1991	1992
Grey-Bruce Counties	0	1
Carden Plain	7	9
Napanee Plain	14	31
Smith's Falls Plain	8	14
Province of Quebec	1	2
Total	29	55

Table 1.4. Number of 1991 territories reoccupied by breeding pairs and percent of reoccupancy by Loggerhead Shrikes in 1992 in southern Ontario and Quebec.

Core Area	1992	
	No. breeding pairs	Percent reoccupancy
Carden plain	4	67%
Napanee plain	12	86%
Smith's Falls plain	6	75%
Province of Quebec	1	100%

Table 1.5. Number of suitable, no longer suitable and reoccupancy rate of historic Loggerhead Shrike territories in southern Ontario.

Core Area	No. suitable unoccupied	No. longer suitable	No. occupied 1991 and 1992	Percent reoccupancy
Grey-Bruce counties	6	14	0	0%
Carden plain	40	3	7	18%
Napanee plain	16	20	12	75%
Smith's Falls plain	12	25	3	8%

Figure 1.1. All 10 by 10 km Ontario Breeding Bird Atlas squares with probable or confirmed evidence of breeding Loggerhead shrikes during the five year period of 1981-1985 (from Cadman *et al.* 1987).

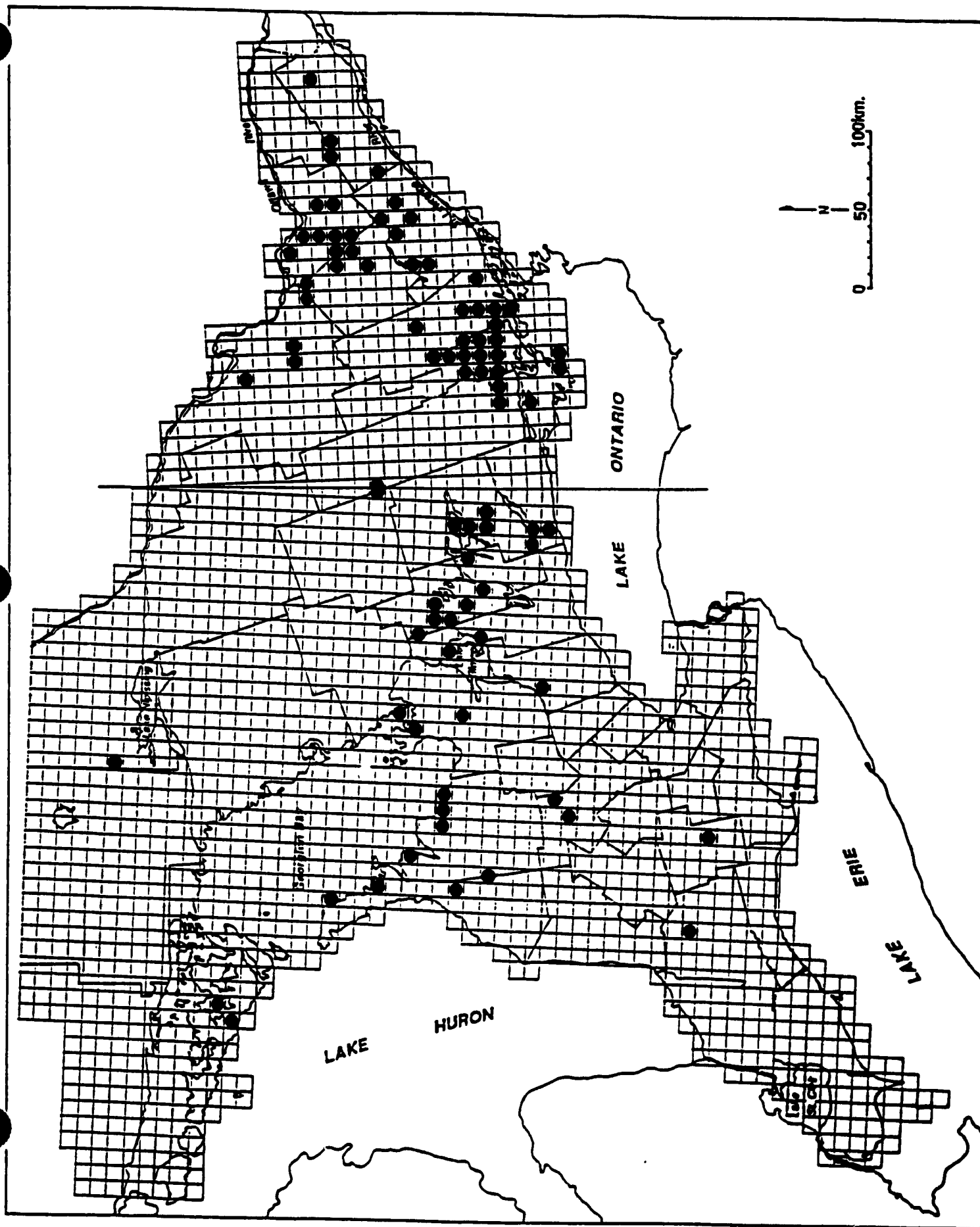


Figure 1.2. All 10 by 10 km Ontario Breeding Bird Atlas squares with confirmed evidence of breeding Loggerhead Shrikes in 1991.

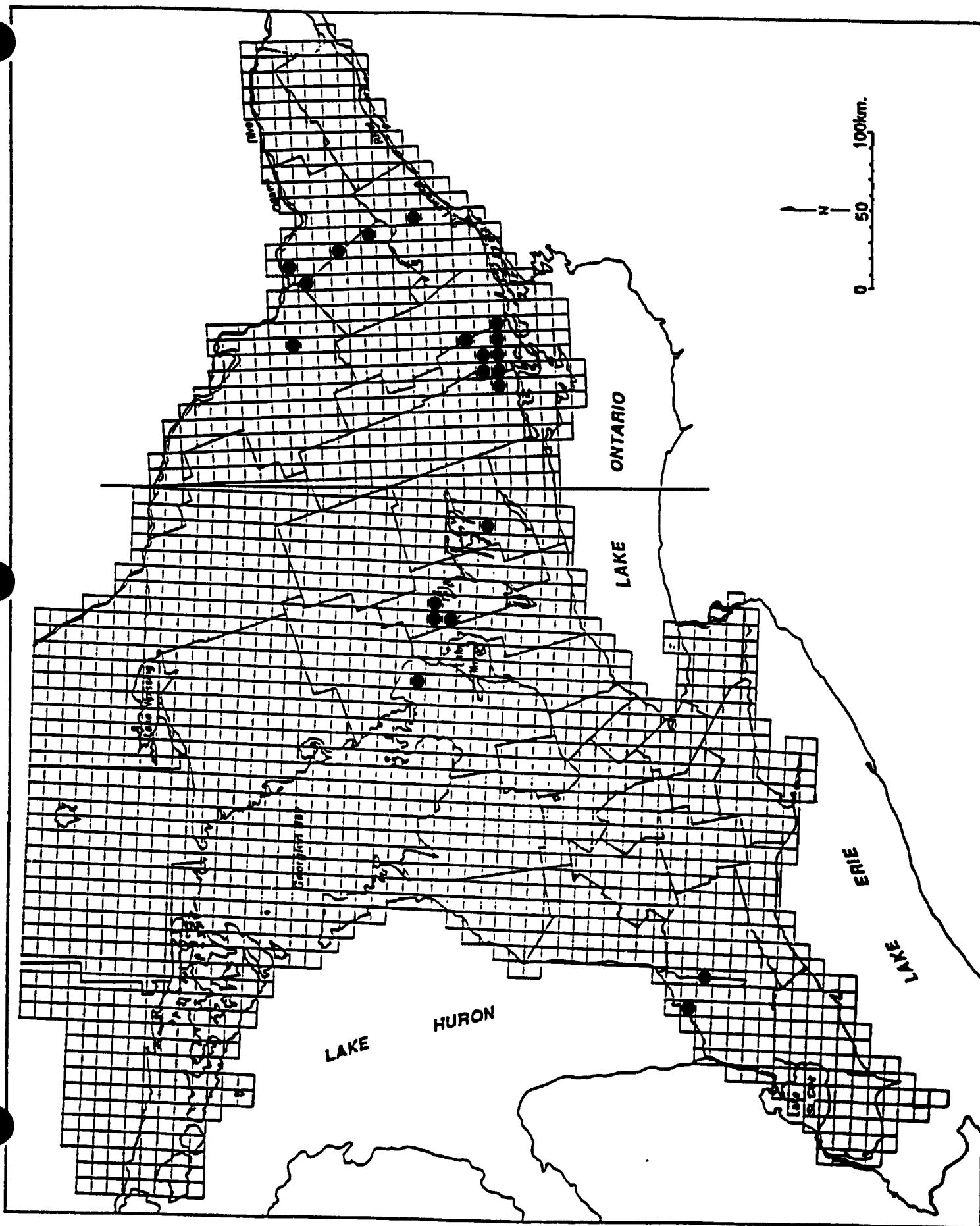


Figure 1.3. All 10 by 10 km Ontario Breeding Bird Atlas squares with confirmed evidence of breeding Loggerhead Shrikes in 1992.

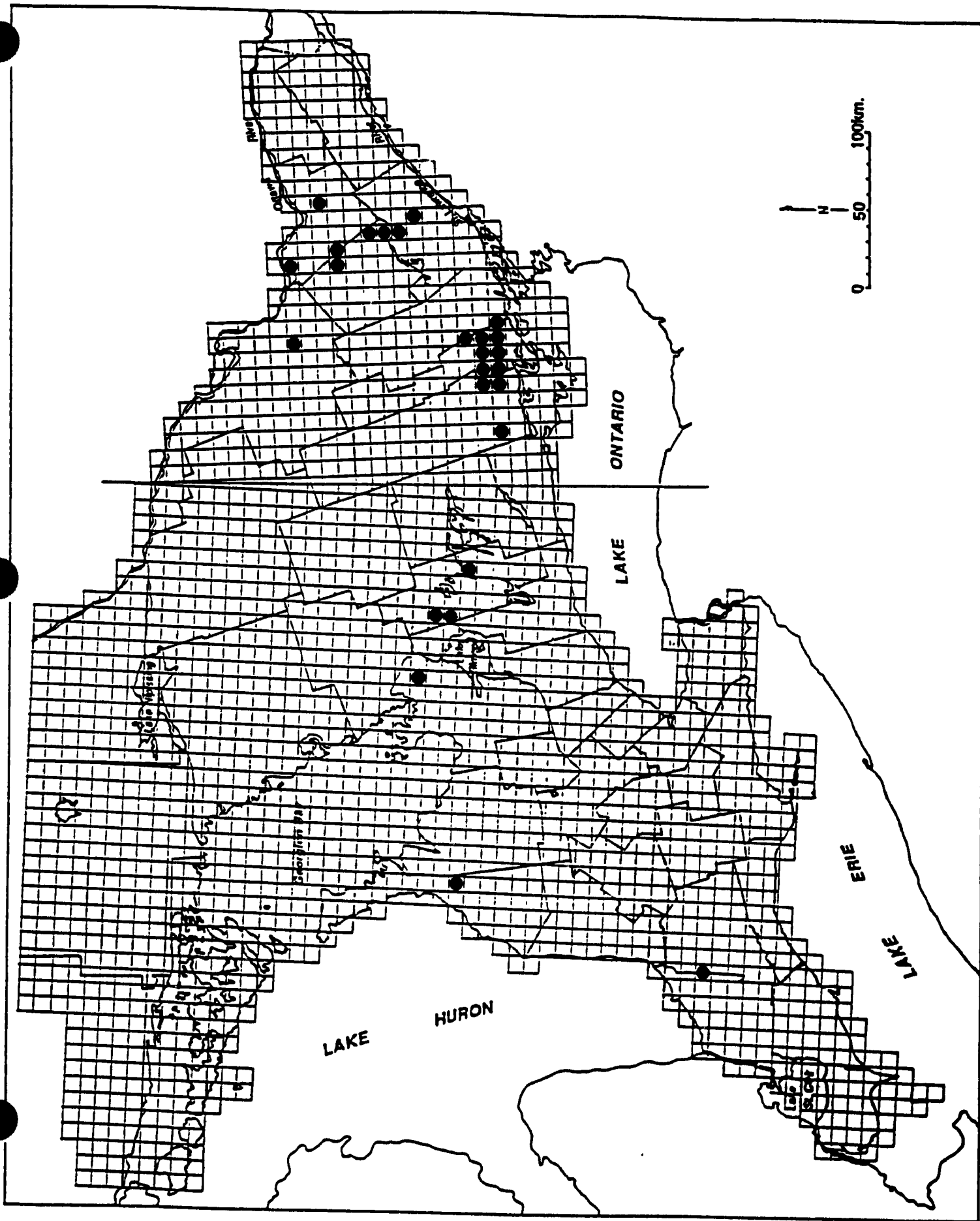
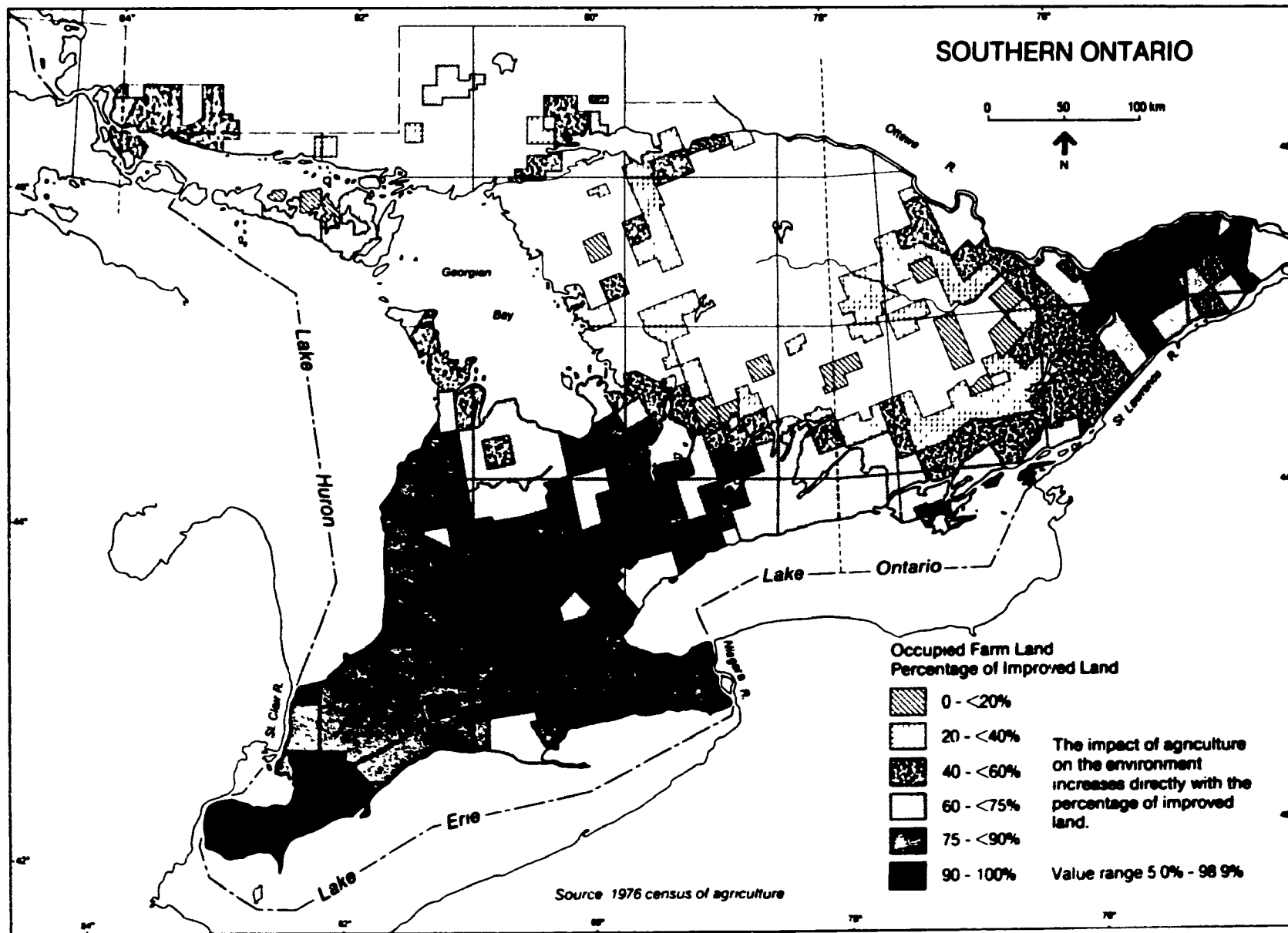


Figure 1.4. "Improved" land as a percentage of farm land
southern Ontario according to the 1976 census of
agriculture (Cadman *et al* 1987).



Connecting Statement

While it is imperative to the conservation of an endangered species to have a knowledge of its population status and trends, it is of equal or greater importance to understand those factors which contribute to the decline of the species. Section 3 deals with the habitat selection of the Loggerhead Shrikes breeding in Ontario and Quebec, in particular characteristics of the nest tree, vegetation composition and height, tree density and amount of available habitat as well as investigating the possible role of disturbance by roads, traffic and houses on the suitability of the habitat. The results of this paper will aid in understanding the changes to breeding habitat and the characteristics of habitat which influence the site selection by breeding Loggerhead Shrikes.

SECTION 3:
**HABITAT SELECTION OF LOGGERHEAD SHRIKES BREEDING
IN ONTARIO AND QUEBEC**

A.A. Chabot, R.D. Titman and D.M. Bird

ABSTRACT

The habitat selection of Loggerhead Shrikes (*Lanius ludovicianus migrans*) breeding in the provinces of Ontario and Quebec, Canada was studied in 1991 and 1992. Thirty seven (50%) of 73 nests were found in hawthorn trees (*Crataegus* spp.), 29 (40%) were located in red cedar trees (*Juniperus virginianus*), while white cedar (*Thuja occidentalis*), buckthorn (*Rhamnus catharticus*) and ash (*Fraxinus* spp.) were used infrequently (10%). Sixty two nests (86%) were located in isolated trees or in a copse and 10 (14%) in hedgerows. Fifty one (64%) of the sites were located in actively grazed pastures. The average height, width and concealment of nesting trees did not differ significantly between active and suitable unoccupied sites. Few differences were detected between active and inactive sites in the average height of the vegetation within a 10 metre radius of the nest tree and the composition of the ground cover as measured on a scale of 1 to 5 (1=0-10%, 2=10-25%, 3=25-50%, 4=50-75%, 5=+75%). The average number of shrubs per hectare did not differ between active and unoccupied sites. Active nesting trees in the Smith's Falls area were found to be located closer to roads than arbitrarily chosen trees in inactive sites. No other differences in the distance to roads, houses and other sources of disturbance were found between active and unoccupied sites. Much habitat became unusable due to lack of hunting perches. While many historic nesting sites were reoccupied, the amount of potential habitat around historic and suitable unoccupied sites indicated that habitat fragmentation may

have influenced site selection.

Introduction

The Loggerhead Shrike (*Lanius ludovicianus*) has a widespread distribution throughout North America. Across its range it uses a range of similar habitats and will nest in open regions with hedgerows, scattered trees and shrubs. Within the past several decades the Loggerhead Shrike has undergone a marked decline over much of its range (Peterson 1965, Erdman 1970, Geissler and Noon 1981, Morrison 1981, Cadman 1985). While the causes of the decline are unknown, toxic chemical accumulation, and collisions with automobiles are considered as potential causes (Bent 1950, Erdman 1970, Campbell 1975, Busbee 1977, Anderson and Duzan 1978, Craig 1978). Climatic factors, predation, interspecific competition and human disturbance may also affect shrike numbers (Peakall 1962, Bibby 1973, Campbell 1975, Porter *et al.* 1975, Hartley 1980, Seigel 1980, Kridelbaugh 1983, Cadman 1985). Habitat loss has been suggested as the principal cause of decline in many areas (Kridelbaugh 1982, Graber *et al.* 1973, Bull 1974, Campbell 1975, Smith and Kruse 1992, Prescott and Collister 1993) and is believed to be the greatest threat to the species. However, Cadman (1985) reported that numbers in the east have declined more rapidly than anticipated based on habitat availability. While the characteristics of Loggerhead Shrike breeding habitat have been described by many authors (Porter *et al.* 1975, Seigel 1980, Kridelbaugh 1983, Luukkonen 1987, Gawlick 1988, Brooks and Temple 1990, Prescott and Collister 1993), the suitability and

availability of breeding habitat in southeastern Ontario and Quebec have never before been assessed. If an attempt is to be made to conserve the species, we must understand the environment within which the species lives and whether impacts upon the habitat they select have been responsible for their decline. Therefore, during the breeding seasons of 1991 and 1992 research was conducted to determine the habitat types used by Loggerhead Shrikes in Quebec and southern Ontario. The characteristics of habitat that are selected versus those that are not by breeding Loggerhead Shrikes, considering utilization of different cover types for foraging and nesting and availability of suitable habitat in particular, were studied to determine if site selection occurred randomly.

Study Area

The study of habitat characteristics of territories occupied by Loggerhead Shrikes versus unoccupied sites was conducted in late July and early August at active breeding territories and 20 suitable but unoccupied sites in each of the three core areas in southeastern Ontario. Refer to the description of study areas in Section 2 for more information on the location and characteristics of these core areas.

Methods

This study tested the hypothesis that habitat used at active nest sites was randomly chosen from available habitats. Habitat measurements were designed to examine selection at two scales. The smaller scale (microhabitat) included the nest tree and the habitat within a 10 m radius of the nest tree. Measurements at this scale

were taken in late July or August, after the young had left the nest tree and reached the stage of independence. The nearest neighbouring tree to the nest tree suitable for nesting was paired with the nest tree for comparison to determine if nest site selection within a site was random. In addition, 20 visually suitable but unoccupied sites which had never been known to have supported breeding shrikes within the 3 core areas of shrike breeding concentration were selected for each of the 3 types of habitat: scattered red cedar fields using an isolated tree for sampling, scattered hawthorn fields using an isolated tree for sampling and hedgerows with hawthorns present as the sample tree. One tree appearing visually suitable for nesting was arbitrarily selected for measurement within the habitat. Comparisons were made to determine if territories selected differed in any way from sites which had never been occupied and was therefore determined by some factor within a site. The proportion of suitable unoccupied sites in each core area approximated the proportion of the total number of nest sites located in each of the 3 previously mentioned habitat classes within each core area.

At each nest tree, neighbour tree and arbitrarily chosen tree several variables were measured. The species, height, width, location and percent concealment of the tree were recorded. Heights were measured with a optical range finder at a distance of 20 metres from the tree and width was measured at the widest point of the tree with a tape measure. Both measurements were taken to the nearest 0.1 m. Percentage of concealment of the tree was

measured using a spherical densiometer (Lemmon 1956) held flat in the palm of the hand with the arm close to the body and bent at a 90 degree angle to the body. Measurements were taken at a south, east, west and north facing direction around the tree and averaged to give the final measure of concealment. The location of the nest tree was recorded as being isolated, in a hedgerow or in a copse. Isolated trees were trees in fields that were not in a definite line or row as were trees in a hedgerow or copse. Trees in a hedgerow or copse were further characterized by having overlapping canopies.

Ground vegetation characteristics were measured around each nest tree and arbitrarily chosen tree. Four 10 m transects were used to quantify herbaceous ground cover. The first was positioned in a randomly chosen direction, starting at the edge of the tree canopy. The three others were positioned at 90° , 180° and 270° relative to the first. Measurements of vegetation composition were taken in a 56.4 cm radius circular plot at 1 m and 10 m from the edge of the canopy along each transect for a total of 8 plots per tree. The composition of each of the following classes of ground cover was measured on a scale of 1 to 5 (1=0-12%, 2=12-25%, 3=25-50%, 4=50-75% and 5=75-100%): bare ground, wildflower, grass or forb, tree or shrub and moss or lichen. Height of vegetation was measured to the nearest 0.01 m at 1, 5 and 10 m from the edge of the canopy and the three measurements were averaged to obtain an average vegetation height which was compared to that at 1 and 10 m distance from the edge of the canopy.

The second scale of selection (macrohabitat) included habitat characteristics measured within a 200 m radius of the nest tree. Shrub density for all shrubs less than 1 m in height and greater than 1 m in height was calculated at each site. The shrub density was measured using tenth acre circles (James and Shugart 1970) sampled by recording the number of trees intercepted by one's outstretched arms (1.8 m) while walking along a compass line for 11.1 m (radius of 0.1-acre circle). The total number of shrubs counted in 2 transects in each of 5 0.1-acre (0.04 hectares) circles times 10 equals an estimate of shrubs per acre. The territory was classified as being either active pasture, idle pasture, old field, hayfield or land cultivated with a row crop. Active pastures differed from idle pastures in the intensity of grazing during the spring and summer. Active pastures were grazed intensively and were characterized by short grass length. Idle pastures received little or no grazing pressure. Hayfields were maintained by mowing. Old fields, identified by the presence of perennial weeds and invading woody plants, were not grazed or mowed.

All other measurements were taken from aerial photographs at a scale of 1:10,000 or 1:15,840, depending upon availability of recent airphoto coverage for each site. The plots were centred on the nest tree and on the arbitrarily selected tree. When there were multiple nestings at a single breeding site, a visual estimate of the arithmetic centre of the nest trees was used as the centre point. A circle of 400 m radius (50 ha) has been determined to

encompass most or all of a shrike's breeding territory (Brooks and Temple 1990) and has been used for management purposes in Ontario. Shrikes have a tendency to space themselves at regular intervals with a buffer zone between their territories, therefore the amount of potential Loggerhead Shrike habitat within a 1 km radius of the nest was also measured. The amount of potential shrike habitat within a 5 km radius was measured in order to determine the role of habitat fragmentation. The distance to roads, houses and other sources of disturbance such as gravel pits and quarries was measured. The number of cars to pass on nearby roads every hour was noted during observations at active breeding sites and was used to determine the amount of disturbance caused by traffic at the active breeding territories.

When determining the amount of potential habitat within a 5 km radius of sites, areas of 10 ha in size or larger were mapped as this is the minimum area believed to be able to support a pair of breeding shrikes (Dyer and Cadman 1991). Units of 1 ha in size were distinguished for the more detailed mapping 400 m around the nest site. Included as utilizable habitat were a 10 m zone into the edge of forested areas when bordering areas of potential habitat. In addition, all patches of forested area smaller than 30 m in width were included as utilizable habitat. A 20 m zone on either side of hedgerows was considered as utilizable habitat based upon the observed distance of shrike hunting forays. Areas located inside the 400 m radius from the nest and within the boundary of the suitable shrike habitat but which did not possess scattered

trees and shrubs or fall within the guidelines above were excluded as "dead space". Due to the lack of sufficient hunting perches these areas were considered as unusable by shrikes for the purposes of the more detailed mapping. A dot grid was made using graph paper of approximately 5 mm by 5 mm and the total area of shrike habitat both with and without the "dead space" was measured and compared for each site.

Comparisons of means using the Student's t-test for normally distributed populations and medians using the Mann-Whitney Rank Sum test for data that were not normally distributed were done with the SigmaStat software package (SigmaStat 1992).

Results

Thirty seven of all nest trees chosen by Loggerhead Shrikes in 1991 and 1992 were hawthorn trees while 28 nests were constructed in red cedars. Other nest sites included 5 in white cedar, 1 in buckthorn and 1 in a large ash tree. The majority of nest trees chosen in the Carden plain and Smith's Fall plain were hawthorn, while the Napanee plain was characterized by red cedar trees (Table 2.1). Nesting trees were most commonly isolated trees (88%) located in actively grazed fields of scattered trees and shrubs. A few nesting trees (8%) were located in hedgerows, most often adjacent to hayfields (Table 2.2). Some territories were located in areas of idle pasture (18) or old field (4), but no active territories were located in or adjacent to rowcrops (Table 2.3).

The comparison of active nesting hawthorns located in hedgerows and arbitrarily chosen hedgerow hawthorns indicated that

they were significantly different in the degree of concealment offered (Mann-Whitney U-test, $p < 0.05$) (Table 2.4). In addition, the height of red cedar nesting trees was significantly greater than that of their nearest neighbouring trees (Mann-Whitney U-test, $p < 0.05$). Other comparisons between nesting trees, nearest neighbour trees and arbitrarily chosen trees at inactive sites showed no statistically significant differences between heights, widths and concealment (all Mann-Whitney U-tests, $p > 0.05$).

The height of vegetation ranged from 29 to 44 cm at active nest sites and from 20 to 35 cm at inactive sites (Table 2.5). There were no statistically significant differences for heights at 1 m and 10 m or for the average height of vegetation between any of active sites and between the active sites and suitable unoccupied sites (all Mann-Whitney U-tests, $p > 0.05$).

Very few statistically significant differences were found in the ground cover composition between active and inactive sites. Grass cover was significantly greater at active sites than at inactive sites (Mann-Whitney U-test, $P < 0.05$). The amount of tree and shrub cover at isolated active red cedar sites was significantly greater than at similar inactive sites (Mann-Whitney U-test, $P < 0.05$). The bare ground at hedgerow hawthorn active sites was significantly greater than at similar, unoccupied sites (Mann-Whitney U-test, $P < 0.05$). The moss/lichen cover at both isolated active hawthorn and red cedar sites was significantly greater than at the active hedgerow hawthorn sites (Mann-Whitney U-test, $p < 0.05$).

The mean number of trees and shrubs per acre (0.40 hectares) that were less than 1 m tall ranged from 86.1 to 147.3 at all active sites and from 117.4 to 120.5 at all suitable unoccupied sites. The mean number of trees and shrubs per acre that were greater than 1 m tall ranged from 79.6 to 121.0 for all active sites and from 92.0 to 93.7 at all suitable unoccupied sites. There were no statistically significant differences detected between active and inactive sites (all Mann-Whitney U-tests, $p > 0.05$).

The average distance to the nearest road, house or other source of disturbance such as railroad tracks, gravel pits or quarries was from 96.0 m to 137.8 m, 245.8 m to 344.9 m and 310.0 m to 608.6 m at all active sites, respectively (Table 2.8). At inactive sites the average distance to roads, houses and other sources of disturbance ranged from 108.5 m to 232.1 m, 316.0 m to 366.8 m and 280.0 m, respectively. Nesting trees at active isolated hawthorn sites were significantly closer to roads than arbitrarily chosen trees at inactive sites (Mann-Whitney U-test, $p < 0.05$). No other comparisons revealed significant differences (all Mann-Whitney U-tests, $p > 0.05$).

Comparisons on data grouped according to area indicated that active nesting trees in active sites in the Smith's Falls plain area were closer to roads than arbitrarily chosen trees (Mann-Whitney U-test, $P < 0.05$). The traffic volume per hour at sites in the Napanee plains area was significantly greater than that in the Smith's Falls plains area (Mann-Whitney U-test, $p < 0.05$) (Table

2.9) .

The amount of potential habitat within 400 m of a nesting site was significantly greater with dead space than that without dead space for all comparisons, both by the type of nesting tree and by the core area, indicating the presence of a significant amount of unsable habitat due to absence of adequate perching sites (all Mann-Whitney U-test, $p < 0.05$) (Table 2.10). The amount of suitable habitat within 400 m of isolated red cedar trees was significantly greater at active sites than at inactive sites (Mann-Whitney U-test, $p < 0.05$). The amount of habitat around active, isolated hawthorn nesting trees was significantly greater than that around active red cedar sites when compared both with and without dead space (Mann-Whitney U-test, $p < 0.05$). As well, the amount of habitat without dead space was significantly greater at both isolated hawthorn and red cedar nesting sites than at hawthorn hedgerow nesting sites (Mann-Whitney U-test, $p < 0.05$) (Table 2.10).

When the data are arranged according to the core area, comparisons indicate that the amount of suitable habitat within 400 m of nesting trees is significantly different at active sites than at inactive sites in both the Napanee and Smith's Falls plains areas (all Mann-Whitney U-tests, $p > 0.05$) (Table 2.11).

The amount of potential habitat within 1 km of the nesting tree at active sites was significantly greater than at inactive sites in both the Smith's Falls and Carden plains areas (Mann-Whitney U-test, $P < 0.05$) (Table 2.12).

Comparisons indicated that the amount of suitable habitat within a 5 km radius of the nesting tree was significantly greater at active sites than at both inactive or historic sites (Mann-Whitney U-test, $p < 0.05$). In addition, the amount of potential habitat around active nesting sites in the Carden plain area was significantly greater than at active sites in the Smith's Falls plain area, Napanee plain area and in the province of Quebec (Mann-Whitney U-test, $p < 0.05$) (Table 2.13).

Discussion

Loggerhead Shrikes nested most commonly in hawthorn and red cedar trees in southern Ontario with more hawthorns being used than red cedar. While hawthorn was the most common nest tree used in the Carden plain and Smith's Falls plain areas, more red cedar trees were used in the Napanee plain area than hawthorns. Other authors have commented on the shrike's preference for red cedar and hawthorn and have commented on the importance of dense, thorny trees such as these trees for nesting (Kridelbaugh 1983, Peck and James 1987, Brooks and Temple 1990, Gawlick and Bildstein 1990, Tyler 1992). Luukkonen (1987) suggested that nests in cedar and hawthorn were more concealed than nests in other locations. Gawlick and Bildstein (1990) pointed out that hawthorns have thorns and red cedar have prickly needles that may discourage predators.

Only 13% of the shrikes nested in hedgerows despite their implication as nesting sites in other studies. However, 6 of 7 Loggerhead Shrike territories used in the last 5 years in Quebec were located in hedgerows (Chabot 1993). Eighty three percent of

shrikes nesting in Ontario chose isolated trees and 4% used a copse, a greater rate than reported elsewhere. Kridelbaugh (1983) reported that 62% of nests in his study were located along fence lines or hedgerows. Seigel (1980) likewise found 65% of all shrike nests located in hedgerows associated with pastures. Gawlick and Bildstein (1990) also reported that shrikes commonly nested in fencerows or hedgerows. However, Brooks and Temple (1990) found that only 32% of the shrikes in their study nested in either a hedgerow or windbreak, while 61% of nests were located in isolated trees which is more characteristic of the present study.

Active and idle pasture accounted for 86% of the territories in this study, making evident the importance of grazers in shrike territories. Brooks and Temple (1990) found only 18% of shrike nests to be in pasture, 45% in grassland habitat and 37% located next to a rowcrop or noncrop field. However, other studies have shown pasture to comprise between 54% (Gawlick and Bildstein 1990) and 67% (Kridelbaugh 1983) of the habitat around active nest sites with the remainder composed of hayfields, residential lawns, fallow fields, or urban areas which is more characteristic of the results found in this study. Shrikes were described by Miller (1931) and Bent (1950) to be birds of farming country. More recently many researchers have reported on the importance of open habitat types to Loggerhead Shrikes, especially pastures, grassland and hayfields (Gawlick 1988, Luukkonen 1987, Kridelbaugh 1982, Seigel 1980 and Porter *et al.* 1975, Smith and Kruse 1992, Telfer 1992) which is consistent with what was found in this study.

The average height and density of the nest tree found in this study are similar to the results of Gawlick and Bildstein (1990) and Scott and Morrison (1990) who reported that shrikes "only nested in shrub species over 2 m tall. Results of comparisons with the nearest neighbouring tree to active nest trees that were suitable for nesting and an arbitrarily chosen tree at suitable unoccupied sites indicates that shrikes randomly selected nesting sites within a suitable territory. Results of analysis of vegetation height indicated no difference between sites. In addition, few differences were found in the composition of ground cover between sites. Therefore, it would appear that shrikes randomly selected habitats on the basis of these microhabitat characteristics but selected sites with dense, thorny nesting trees in actively grazed areas.

The optimal height of ground cover for shrikes and the importance of grazers within shrike territories is seemingly in debate. Prescott and Collister (1993) were of the opinion that the population of Loggerhead Shrikes in Alberta was limited by the availability of high-quality habitats for breeding. They believed management practices which increased the prevalence of tall grass and reduced grazing pressure could render areas more suitable for occupation by shrikes. However, Brooks and Temple (1990) believed that more open habitat was better suited for shrike occupancy. Gawlick and Bildstein (1990) also reported that shorter vegetation would increase a shrike's hunting efficiency and that this "would be important during the breeding season when adults are providing

approximately 165 food items per day to their nests." The American Kestrel (*Falco sparverius*), which is similar in diet and habitat requirements to the Loggerhead Shrikes in portions of its range exhibits reduced hunting success with increasing height of vegetation (Toland 1987).

Yosef and Grubb (1993) reported that shrikes are typically found in habitats that are marked by short vegetation. While they considered taller vegetation to be "sub-optimal" habitat, their results did not support the hypothesis that the rate of prey capture is severely limited in habitats with tall grasses or shrubs. Shrikes were able to adjust to modifications of their habitat by altering their hunting behaviour. However, the increased time spent in aerial pursuits under tall grass conditions did affect "personal-maintenance activities" as less time was spent preening and resting and they believed that "their results substantiated the conclusions of others (e.g., Brandl *et al.* 1986, Bohall-Wood 1987) that grassland habitats permit energetically efficient hunting in shrikes."

In reality, a variety of vegetation heights may be more important than homogeneous tall or short grass. The presence of grazers at sites creates a heterogeneous effect as the height of grass is tall around the grazer's droppings and short where the grass has been eaten. Many types of insects use the droppings as habitat (Mohr 1943) and thus may provide an important source of food for shrikes. The shrikes' perch and wait hunting technique may help them spot insects as they move from dropping to dropping.

Without the presence of these "ecological units", the amount of insect prey and a shrike's hunting success may be affected.

The availability of food resources may also be a factor in the selection of open, grassed habitats over rowcrop and hayfields. Due to the small size of the shrike, tall grass would not only make prey difficult to spot but difficult to capture. While the extent of pesticide use and prey availability was not investigated, one would expect reduced insect populations in the rowcrops due to weed and insect control activities. Grazed areas may not be subject to applications of pesticides and this factor, as well as vegetation height, may couple to increase the suitability of such sites for use by Loggerhead Shrikes.

No differences were detected which would indicate that shrikes tended not to nest near houses, railroad tracks, quarries, gravel pits or other sources of disturbance, however, active nest sites were located closer to roads than haphazardly chosen trees in suitable unoccupied sites. In Ontario, there have been two reported cases of road-killed shrikes, one suspected case of the death of an adult due to collisions with a vehicle and several anecdotal observations of near misses. The effect of human disturbance on breeding shrikes appears to be variable and depends upon the individual pair's behaviour (Campbell 1975). However, the shrikes' apparent tendency to nest close to roads and their utilization of roadside ditches and road surfaces for foraging may tend to increase their susceptibility to collisions (Robertson 1930, Miller 1931, Bent 1950, Zimmerman 1955, Smith 1973, Bull

1974, Campbell 1975, Craig 1978). Miller (1931) estimated that 20% of the population he observed died as a result of collisions with vehicles. In Virginia, Luukkonen (1987) reported that 17.6% of his known mortality involved juvenile birds which had been killed by vehicles. Gawlick and Bildstein (1990) knew of 2 cases in which shrike mortality was a result of collisions with vehicles.

Brooks and Temple (1990) suggested that a 50 ha circular plot (equivalent to a radius of 400 m around the nest) will encompass the area likely to be used by a breeding pair of shrikes. Similarly, Prescott and Collister (1993) assumed that territories were approximately 200 m in diameter. Other estimates of territory size for shrikes are much lower, ranging from 4.6 ha (Kridelbaugh 1982) to 7.5 ha (Miller 1931) and other studies on the genus *Lanius* report territory sizes to range from 1.6 to 10.5 ha (Kridelbaugh 1982). While the amount of suitable habitat within an area will have a direct influence upon the size of a territory, Yosef (1993) found that hunting perches in a given area were a limiting resource for male Great Grey Shrikes. He proposed that the addition of hunting perches could decrease the size of a male's territory. With this in mind the suitability of the habitat chosen at active nesting sites was compared to that at suitable unoccupied sites in southern Ontario on the basis of the amount of actual utilizable habitat within an area. Areas within a 400 m radius of the nest tree were assessed based upon the availability of hunting perches and the area around them versus areas without perches which were considered as "dead space" due to the lack of opportunity for

shrikes to perch in these areas. Isolated hawthorn sites had more potential habitat than isolated red cedar sites and based upon the amount of utilizable habitat, hedgerow sites were less suitable than sites with scattered trees and shrubs. There was no difference in the amount of potential habitat either with and without dead space between active and suitable unoccupied sites based upon the type of nesting site. Yet, within each of the three core areas, the amount of utilizable habitat was greater at active sites than at suitable unoccupied sites except in the Smith's Falls area. The results indicate that while sites may appear to be visually suitable there are differences in the amount of utilizable habitat within sites which may be important to nesting shrikes as demonstrated by Yosef (1993).

Habitat loss has been suggested by several authors to be one of the most important possible causes of decline in Loggerhead Shrike numbers and therefore the majority of the work done concerning causes of decline has centred on this factor. Brooks and Temple (1990) believed there to be much suitable habitat unoccupied in Minnesota and this opinion has been reported by other authors as well (Kridelbaugh 1983, Luukkonen 1987, Gawlick 1988). However, none of these studies has taken into account the possible importance of the availability of potential habitat on the suitability of nesting sites. Active sites in the Smith's Falls and Carden area had a significantly greater amount of habitat within a 1 km radius around them than did inactive or historic sites. It is interesting to note that the amount of habitat within

a 1 k radius of active sites in the Napanee plain did not differ from inactive or historic sites at this scale and it is within this area that half of the population of shrikes in Ontario is found. All active sites within each of the three core areas in Ontario had a significantly greater amount of potential habitat within a 5 k radius than did inactive and historic sites. This suggests that the amount of habitat around a nesting site may affect the suitability of nesting sites. However, much apparently suitable habitat does exist on the local scale and few or no significant differences can be found among most of the variables tested at active sites and inactive sites, indicating that nest site selection is random.

The results of our study indicates that the first step toward the successful conservation of the Loggerhead Shrike in Ontario is the protection of habitat at a much larger scale than that which is presently occurring. However, active nest sites to date have all been found on private land and therefore, this task will be complicated. The most successful attempts at saving this species will most likely come when the plight of the shrike is better known and the aid of landowners is enlisted. Communication plans and incentive programs which encourage landowners to maintain grazers and the "unimproved" nature of their land may be the first steps toward the conservation of the species. Efforts to improve existing active sites and historic sites through the addition of perches or clearing of overgrown areas where succession has begun to take over will help to increase the amount of habitat and the

suitability of sites. For these tasks, the labour of landowners, local naturalist groups and interested public could join. The shrike is a unique member of the avifauna of the Ontario plains and efforts to save this species may also help preserve habitat for other species.

Literature Cited

- Anderson, D.W. and R.E. Duzan. 1978. DDE residues and eggshell thinning in Loggerhead Shrikes. *Wilson Bull.* 90:215-220
- Bent, A.C. 1950. Life histories of North American wagtails, shrikes, vireos and their allies. *U.S. Natl. Mus. Bull.* 197:114-182.
- Bibby, C. 1973. The red-backed shrike: A vanishing British species. *Bird Study* 20:103-110.
- Bohall-Wood, P. 1987. Abundance, habitat use, and perch use of Loggerhead Shrikes in north-central Florida. *Wilson Bull.* 99:82-86.
- Brandl, R.W., Lubcke, and W. Mann. 1986. Habitat selection in the Red-backed Shrike (*Lanius collurio*) *J. Ornithol.* 127:69-78.
- Brooks, B.L. and S.A. Temple. 1990a Habitat availability and suitability for Loggerhead Shrikes in the Upper Midwest. *Am. Midl. Nat.* 123: 75-83.
- Bull, J. 1974. *Birds of New York State*. Doubleday Natural History Press, New York.
- Busbee, E.L. 1977. The effects of dieldrin on the behaviour of young Loggerhead Shrikes. *Auk* 94:28-35.
- Cadman, M.D. 1985. Status report on the Loggerhead Shrike (*Lanius*

ludovicianus) in Canada. Draft report for the Committee on the Status of Endangered Wildlife in Canada.

Campbell, C. 1975. Distribution and breeding success of the Loggerhead Shrike in southern Ontario. Can. Wildl. Serv., Report No. 6055, unpublished report.

Chabot, A.A. 1993. Loggerhead Shrike habitat availability and suitability in Quebec. Can. Wild. Serv. unpublished report.

Craig, R.B. 1978. An analysis of the predatory behaviour of the Loggerhead Shrike. Auk 95:221-234.

Dyer, M., and M.D. Cadman. 1991. Loggerhead Shrike habitat survey, Napanee District, June 1991. Ont. Ministry of Natur. Resour., Napanee, Ontario. Unpublished report.

Erdman, T.C. 1970. Current migrant shrike status in Wisconsin. Passenger Pigeon. 35:144-150.

Gawlick, D. 1988. Reproductive success and nesting habitat of loggerhead shrikes and relative abundance, habitat use, perch use of loggerhead shrikes and American kestrels in South Carolina. M. Sc. thesis, Winthrop College, Rock Hill, South Carolina.

Gawlick, D.E. and K.L. Bildstein. 1990. Reproductive success and nesting habitat of Loggerhead shrikes in North-Central South Carolina. Wilson Bull. 102:37-48.

Geissler, P.H. and B.R. Noon. 1981. Estimates of avian population trends from the North American breeding bird survey. Pages 42-51 in Estimating the numbers of terrestrial

- birds, C.J. Ralph and M.Scott (eds). Studies in Avian Biology 6.
- Graber, R.R., J.W. Graber and E.L. Kirk. 1973. Illinois birds: Laniidae. Biol. Ser. No. 83. State of Illinois.
- Hartley, R. 1980. Shrike strike. Blue Heron 24:13-14.
- James, F.C. and H H. Shugart, Jr. 1970. A quantitative method of habitat description. Aud. Field Notes 24:727-736.
- Kridelbaugh, A.L. 1982. An ecological study of Loggerhead Shrikes in central Missouri. M.Sc. thesis. Univ. of Missouri, Columbia, Missouri.
- Kridelbaugh, A. 1983. Nesting ecology of the Loggerhead Shrike in central Missouri. Wilson. Bull. 95:303-308.
- Lemmon, P.E. 1956. A spherical densiometer for estimating forest overstory density. Forest Science 2:314-320.
- Luukkonen, D.R. 1987. Status and breeding ecology of the loggerhead shrike in Virginia. M.Sc. thesis. Virginia Polytechnic Institute and State University, Blacksburg, Virginia.
- Miller, A.H. 1931. Systematic revision and natural history of the American shrikes (*Lanius*). Univ. of Calif. Pubs. in Zool. 38:11-242. University of California Press, Berkeley.
- Mohr, C.O. 1943. Cattle droppings as ecological units. Ecol. Monog. 13:277-298.
- Morrison, M.L. 1981. Population trends of the Loggerhead Shrike in the United States. Am. Birds 35:754-757.
- Peakall, D.B. 1962. The past and present status of the red-backed shrike in Great Britain. Bird Study 9:198-216.

- Peck, G.K. and R.D. James. 1987. Breeding birds of Ontario, nidiology and distribution, Volume 2: Passerines. The Royal Ontario Museum, Toronto, Canada.
- Peterson, P.C. 1965. Spring migration. Middlewestern prairie region. Aud. Field Notes 19:480-482.
- Porter, D.K., M.S. Strong, J.B. Giezentanner and R.A. Ryder. 1975. Nest ecology, productivity and growth of the Loggerhead Shrike on the short grass prairie. Southwest Nat. 19:429-436.
- Prescott, D.R. and D.M. Collister. 1993. Characteristics of occupied and unoccupied Loggerhead Shrike territories in southeastern Alberta. J. Wildl. Manage. 57:346-352.
- Robertson, J.M. 1930. Roads and birds. Condor 32:142-146.
- Scott, T.A. and M.L. Morrison. 1990. Natural history and management of the San Clemente Loggerhead Shrike. Proceedings of the Western Foundation of Vertebrate Zoology, Vol. 4, No.2.
- Seigel, M.S. 1980. The nesting ecology and population dynamics of the Loggerhead Shrike in the blackbelt of Alabama. M.Sc. thesis, Univ. Alabama, Birmingham, Alabama.
- SigmaStat for DOS User's Manual. 1992. Jandel Scientific. San Rafael, California.
- Smith, S.M. 1973. A study of prey-attack behaviour in young Loggerhead Shrikes, *Lanius ludovicianus* L. Behaviour 44:113-141.
- Smith, E.L. and K.C. Kruse. 1992. The relationship between land-use and the distribution and abundance of loggerhead shrikes

in South-Central Illinois. J. Field Ornithol., 63:420-427.

Telfer, E.S. 1992. Habitat change as a factor in the decline of the western Canadian Loggerhead Shrike, *Lanius ludovicianus*, population. Can. Field. Nat. 106:321-326.

Toland, B.R. 1987. The effect of vegetative cover on foraging strategies, hunting success and nesting distribution of American kestrels in Central Missouri. J. Raptor Res. 21:14-20.

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

Yosef, R. 1993. Influence of observation posts on territory size of Northern Shrikes. Wilson Bull. 105:180-183.

Yosef, R. and T.C. Grubb, Jr. 1992. Territory size influences nutritional condition in nonbreeding Loggerhead Shrikes (*Lanius ludovicianus*): A ptilochronology approach. Conservation Biology 6: 447-449.

Zimmerman, D.A. 1955. Notes on field identification and comparative behaviour of shrikes in winter. Wilson Bull. 67:200-208.

Table 2.1. Number of hawthorn, red cedar and other species of trees used as nesting sites by Loggerhead Shrikes in the three core areas of shrike breeding habitat in southern Ontario in 1991 and 1992.

Core Area	Hawthorn	Red Cedar	Other
Carden plain			
1991	5	0	0
1992	6	0	2
Napanee plain			
1991	3	9	1
1992	7	20	0
Smith's Falls plain			
1991	8	0	0
1992	8	0	4

Table 2.2. Spatial relationship of nest trees chosen by Loggerhead Shrikes in the three core areas of breeding habitat in southern Ontario.

Core Area	Isolated hawthorns	Hedgerow hawthorns	Isolated red cedars	Isolated other	Hedgerow other
Carden plain					
1991	7	0	0	0	0
1992	6	0	0	2	0
Napanee plain					
1991	3	0	8	1	0
1992	6	0	20	0	0
Smith's Falls plain					
1991	3	6	0	0	0
1992	5	3	0	2	1
Total	29	9	28	5	1

Table 2.3. Land use classification of active Loggerhead Shrike territories in each of the three core areas of Loggerhead Shrike breeding population in southern Ontario.

Core Area	Active pasture	Idle pasture	Hayfield	Old field	Rowcrop
Carden plain	9	3	0	0	0
Napanee plain	30	9	1	2	0
Smith's Falls plain	12	6	6	2	0

Table 2.4. Mean ($\pm$ S.E.) height (m), width (m) and concealment (%) of active Loggerhead Shrike nest trees, nearest neighbour and arbitrarily chosen trees in suitable unoccupied sites in southern Ontario.

	Height (m)	Width (m)	Concealment
Isolated hawthorn			
Active sites	3.55 $\pm$ 0.17	3.71 $\pm$ 0.21	77.66 $\pm$ 2.80%
Nearest neighbours	3.17 $\pm$ 0.18	3.17 $\pm$ 0.19	78.65 $\pm$ 2.58%
Unoccupied sites	3.85 $\pm$ 0.24	3.95 $\pm$ 0.28	80.76 $\pm$ 2.72%
Hedgerow hawthorn			
Active sites	3.66 $\pm$ 0.31	4.22 $\pm$ 0.75	84.92 $\pm$ 1.20% ^a
Nearest neighbours	*	*	*
Unoccupied sites	3.90 $\pm$ 0.23	3.68 $\pm$ 0.23	93.01 $\pm$ 0.51% ^b
Isolated red cedar			
Active sites	4.98 $\pm$ 0.27 ^c	2.89 $\pm$ 0.18	88.76 $\pm$ 1.80%
Nearest neighbours	4.09 $\pm$ 0.25 ^d	2.56 $\pm$ 0.14	88.55 $\pm$ 1.22%
Unoccupied sites	4.86 $\pm$ 0.26	2.95 $\pm$ 0.21	87.15 $\pm$ 1.49%
Other species			
White cedar	5.65 $\pm$ 0.33	2.93 $\pm$ 0.54	80.50 $\pm$ 7.11%
Buckthorn	3.30	3.80	96.00%
Ash	11.00	5.50	91.75%

ab, cd statistically significant difference
(Mann-Whitney u-test, $p < 0.05$)

Table 2.5. Mean ($\pm$ S.E.) height of vegetation (cm) within a 10 m radius of the nest tree of Loggerhead Shrikes and arbitrarily chosen trees at suitable unoccupied sites in southern Ontario during 1991 and 1992.

	1 metre (cm)	10 metre (cm)	Average height (cm)
Isolated hawthorn			
Active sites	29.42 $\pm$ 2.98	31.27 $\pm$ 3.41	31.55 $\pm$ 3.25
Unoccupied sites	23.51 $\pm$ 3.49	20.18 $\pm$ 2.79	24.56 $\pm$ 3.36
Hedgerow hawthorn			
Active sites	44.72 $\pm$ 11.32	30.13 $\pm$ 6.06	30.33 $\pm$ 5.60
Unoccupied sites	34.40 $\pm$ 4.28	34.69 $\pm$ 3.35	34.94 $\pm$ 3.28
Isolated red cedar			
Active sites	38.87 $\pm$ 4.14	38.27 $\pm$ 6.00	36.69 $\pm$ 3.16
Unoccupied sites	30.20 $\pm$ 5.19	28.06 $\pm$ 3.35	30.39 $\pm$ 4.96
Other species			
Active sites	40.36 $\pm$ 7.61	36.36 $\pm$ 5.89	32.16 $\pm$ 5.30

Table 2.6. Mean ($\pm$ S.E.) composition of ground cover on a scale of 1 to 5 (1=0-12%, 2=12-25%, 3= 25-50%, 4= 50-75%, 5= < 75%) within a 10 m radius of the active nest tree of Loggerhead Shrikes and arbitrarily chosen trees at suitable unoccupied sites in southern Ontario during 1991 and 1992.

	Bare ground	Grass/Forb	Wildflower	Tree/Shrub	Moss/Lichen
Isolated hawthorn					
Active sites	1.77 $\pm$ 0.17	3.29 $\pm$ 0.17a	2.43 $\pm$ 0.08	0.42 $\pm$ 0.09	0.66 $\pm$ 0.11g
Unoccupied sites	1.46 $\pm$ 0.10	2.02 $\pm$ 0.29b	2.42 $\pm$ 0.22	0.26 $\pm$ 0.08	0.59 $\pm$ 0.10
Hedgerow hawthorn					
Active sites	2.36 $\pm$ 0.39c	2.47 $\pm$ 0.63	1.99 $\pm$ 0.24	0.11 $\pm$ 0.06	0.03 $\pm$ 0.03h
Unoccupied sites	1.30 $\pm$ 0.89d	3.60 $\pm$ 0.22	2.48 $\pm$ 0.19	0.03 $\pm$ 0.02	0.01 $\pm$ 0.01
Isolated red cedar					
Active sites	1.73 $\pm$ 0.15	3.20 $\pm$ 0.16	2.62 $\pm$ 0.20	0.37 $\pm$ 0.09e	0.80 $\pm$ 0.12i
Unoccupied sites	1.52 $\pm$ 0.18	3.28 $\pm$ 0.18	2.61 $\pm$ 0.17	0.09 $\pm$ 0.03f	0.72 $\pm$ 0.19
Other species					
Active sites	1.66 $\pm$ 0.33	2.48 $\pm$ 0.40	2.45 $\pm$ 0.24	0.23 $\pm$ 0.15	1.00 $\pm$ 0.22

ab, cd, ef, gh, hi statistically significant difference
(Mann-Whitney U-test, $p < 0.05$)

Table 2.7. Mean ($\pm$ S.E.) shrub and tree density per acre within a 200 m radius of the active nest tree of Loggerhead Shrike territories and arbitrarily chosen trees in suitable unoccupied sites in southern Ontario during 1991 and 1992.

	Less than 1 m tall	Greater than 1 m tall
Isolated hawthorn		
Active sites	147.33 $\pm$ 22.90	121.00 $\pm$ 35.68
Unoccupied sites	117.35 $\pm$ 18.70	92.04 $\pm$ 11.39
Hedgerow hawthorn		
Active sites	*	*
Unoccupied sites	*	*
Isolated red cedar		
Active sites	86.07 $\pm$ 16.35	79.64 $\pm$ 12.31
Unoccupied sites	120.53 $\pm$ 20.91	93.68 $\pm$ 17.99
Other species	105.00 $\pm$ 35.19	97.52 $\pm$ 24.63

* measurements not taken

Table 2.8. The mean ($\pm$ S.E.) distance to the nearest road, house and other sources of disturbance at active isolated hawthorn, hedgerow hawthorn, isolated red cedar and other species of nest trees at active Loggerhead Shrike territories and suitable unoccupied sites in the three core areas of breeding population in southern Ontario during 1991 and 1992.

	Roads Distance (m)	House Distance (m)	Other Distance (m)
Isolated hawthorn			
Active sites	135.64 $\pm$ 27.66a	344.86 $\pm$ 46.60	481.79 $\pm$ 161.06
Unoccupied sites	232.11 $\pm$ 34.32b	366.84 $\pm$ 46.18	*
Hedgerow hawthorn			
Active sites	108.50 $\pm$ 19.20	245.79 $\pm$ 35.02	608.57 $\pm$ 88.68
Unoccupied sites	108.50 $\pm$ 19.20	316.00 $\pm$ 35.01	280.00 $\pm$ 180.00
Isolated red cedar			
Active sites	137.76 $\pm$ 29.40	294.14 $\pm$ 32.66	*
Unoccupied sites	162.22 $\pm$ 23.96	348.24 $\pm$ 59.85	*
Other species			
Active sites	96.00 $\pm$ 31.12	333.13 $\pm$ 102.42	310.00 $\pm$ 92.92

* greater than 1 km

ab statistically significant difference
(Mann-Whitney U-test, $p < 0.05$)

Table 2.9. The mean ($\pm$ S.E.) distance to the nearest road, house, other sources of disturbance and traffic rate per hour at active Loggerhead Shrike territories and suitable unoccupied sites in the three core areas of breeding concentration in southern Ontario during 1991 and 1992.

	Distance (m)	Roads Traffic vol. est. veh./h	House Distance (m)	Other Distance (m)
Carden plain				
Active sites	145.35 $\pm$ 27.36	7.77 $\pm$ 1.80	413.93 $\pm$ 101.07	220.83 $\pm$ 66.65
Unoccupied sites	201.82 $\pm$ 23.93		369.62 $\pm$ 60.47	*
Napanee plain				
Active sites	137.76 $\pm$ 29.40	12.67 $\pm$ 4.27a	294.14 $\pm$ 32.66	*
Unoccupied sites	162.22 $\pm$ 23.96		348.24 $\pm$ 59.85	*
Smith's Falls				
Active sites	126.82 $\pm$ 47.88c	3.72 $\pm$ 0.86b	300.91 $\pm$ 40.51	570.00 $\pm$ 216.38
Unoccupied sites	232.11 $\pm$ 34.32d		366.84 $\pm$ 46.18	*

* greater than 1 km

ab, cd statistically significant difference
(Mann-Whitney U-test, $p < 0.05$)

Table 2.10. Area (mean $\pm$ S.E.) of potential Loggerhead Shrike habitat within a 400 metre radius of isolated hawthorn, isolated red cedar, hedgerow hawthorn and other species of active nest trees and arbitrarily chosen trees at suitable unoccupied sites in southern Ontario.

Core Area	Potential habitat (ha) with "dead space"	Potential habitat (ha) without "dead space"
Isolated hawthorn		
Active sites	45.12 $\pm$ 4.78a	20.11 $\pm$ 1.77b
Unoccupied sites	36.34 $\pm$ 5.22c	18.72 $\pm$ 2.09d
Hedgerow hawthorn		
Active sites	31.96 $\pm$ 1.76e	8.66 $\pm$ 1.53e
Unoccupied sites	27.89 $\pm$ 2.34g	9.76 $\pm$ 2.15h
Isolated red cedar		
Active sites	33.57 $\pm$ 4.91i	15.42 $\pm$ 1.40j
Unoccupied sites	22.47 $\pm$ 1.95k	16.40 $\pm$ 1.30l
Other species		
Active sites	38.06 $\pm$ 6.29m	18.31 $\pm$ 4.72n

ab, cd, ef, gh, ij, kl, mn, ae, ai, ei, ik
statistically significant difference
(Mann-Whitney U-test, $p < 0.05$)

Table 2.11. Number (mean $\pm$ S.E.) of hectares of potential Loggerhead Shrike habitat within a 400 metre radius of active nest trees and arbitrarily chosen trees in suitable unoccupied sites in the three core areas of breeding population in southern Ontario.

Area	Potential habitat (ha) With "dead space"	Potential habitat (ha) Without "dead space"
Carden plain		
Active site	50.33 $\pm$ 1.67a	18.95 $\pm$ 2.54b
Unoccupied site	48.14 $\pm$ 6.87c	20.57 $\pm$ 2.66d
Napane plain		
Active site	33.05 $\pm$ 4.05e	15.31 $\pm$ 1.17f
Unoccupied site	22.47 $\pm$ 1.95g	16.39 $\pm$ 1.30h
Smith's Falls plain		
Active site	36.64 $\pm$ 2.38i	26.41 $\pm$ 1.81j
Unoccupied site	20.13 $\pm$ 2.91k	16.19 $\pm$ 3.35l

ab, cd, ef, gh, ij, kl, eg, ik statistically significant difference
(Mann-Whitney U-test, $p < 0.05$)

Table 2.12. Number (mean $\pm$ S.E.) of hectares of potential Loggerhead Shrike habitat within a 1 k radius of active nest trees and arbitrarily chosen trees in suitable unoccupied sites in the three core areas of breeding population in southern Ontario.

Core Area	Potential habitat (ha)
Carden plain	
Active site	203.13 $\pm$ 14.80a
Suitable unoccupied	175.39 $\pm$ 22.61b
Napanee plain	
Active site	103.21 $\pm$ 7.35
Unoccupied site	119.34 $\pm$ 12.23
Smith's Falls plain	
Active site	149.25 $\pm$ 14.06c
Unoccupied site	57.84 $\pm$ 9.95d

ab, cd statistically significant difference
(Mann-Whitney U-test, $p < 0.05$)

Table 2.13. Number (mean $\pm$ S.E.) of hectares of potential Loggerhead Shrike habitat within a 5 kilometre radius of active nest trees, arbitrarily chosen trees at suitable unoccupied sites and historic nest sites in the three core areas of breeding population in southern Ontario.

Core Area	Potential habitat (ha)
Bruce-Grey counties	
Historic sites	177.88 $\pm$ 48.71
Carden plain	
Active sites	2187.53 $\pm$ 141.31a
Unoccupied sites	1184.11 $\pm$ 291.29b
Historic sites	2020.24 $\pm$ 128.44c
Napaneer plain	
Active sites	1440.92 $\pm$ 112.92d
Unoccupied sites	942.82 $\pm$ 126.22e
Historic sites	701.04 $\pm$ 173.73f
Smith's Falls plain	
Active sites	1672.59 $\pm$ 158.31g
Unoccupied sites	1019.39 $\pm$ 207.28h
Historic sites	378.63 $\pm$ 76.78i
Province of Quebec	
Active sites	1439.00 $\pm$ 127.00j
Historic sites	629.00 $\pm$ 208.43k

ab, ac, de, df, gh, gi, jk, ad, ag, aj
statistically significant difference
(Mann-Whitney U-test, $p < 0.05$)

Connecting Statement

The reproductive performance of a species while on its breeding grounds is of particular importance when trying to determine the factors affecting a species decline. Without the successful rearing of young to replace the present breeders, a population will quickly decline with no chance of recovery unless the factors affecting the reproductive performance can be successfully altered. Also, in assessing habitat selection much can be learned about the value of habitats to the species by comparing reproductive success among habitats. Section 4 deals with the reproductive performance of Loggerhead Shrikes in Ontario in an attempt to ascertain the success of the species in raising young. The timing of onset of breeding, clutch size, reproductive success and difference in success between major habitat types as well as nest characteristics are examined.

SECTION 4:

REPRODUCTIVE PERFORMANCE OF LOGGERHEAD SHRIKES IN ONTARIO

A.A. Chabot, D.M. Bird and R.D. Titman

ABSTRACT

The breeding biology of Loggerhead Shrikes (*Lanius ludovicianus*) was studied in the 3 core areas in southern Ontario, Canada in 1991 and 1992. Shrikes returned from winter ranges to set up territories in April and began egg laying in mid-April. Most females began incubation during the second week of May in both years. Incubation lasted approximately 17 days and young fledged 19 days later. Fledglings spent 2 or 3 days in the nest tree before attempting longer flights. One pair successfully produced two broods in 1991 and 1 of 3 attempts to double brood in 1992 was successful. Two pairs (17%) renested in 1991 after initial unsuccessful attempts with 1 observed to be successful. In 1992, 8 pairs (21%) had unsuccessful first attempts and 3 renested, with 1 observed to be successful. The cause of all but one of the failures was believed to be predation. Twenty-seven pairs were observed in 1991 and 50 in 1992. Clutch size averaged 4.88 in 1991 and 5.58 in 1992. In 1991, 4.20 eggs hatched per nest compared with 5.56 in 1992. Of these, 3.90 young fledged per nest in 1991 and 4.17 in 1992. However, only 2.30 young survived to independence in 1991 and 2.47 in 1992. Eighty-nine percent of the breeding pairs were successful in fledging at least one young in 1991 and 78% fledged at least one young in 1992. The probability that an egg laid would survive to fledge in isolated red cedars, isolated hawthorn, hedgerow hawthorn and other species of tree was 58.56%, 76.20%, 88.46% and 92.86%, respectively.

Introduction

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) became concerned about the status of the Loggerhead Shrike (*Lanius ludovicianus*) in Ontario and Quebec in the early 1980's with reports of declining populations in both the United States and Canada. The eastern subspecies (*L. l. migrans*) was designated as "threatened" in 1986 and its status was upgraded to "endangered" in 1991. Due to the continued decline in numbers, the small size of the remnant population and threats to the species primary breeding sites, the Loggerhead Shrike was designated as "endangered" in the province of Ontario in November, 1992. The migrant race of Loggerhead Shrike breeds from eastern Manitoba through Ontario and southern Quebec (Cadman 1985). The species is near virtual extirpation in Quebec and populations have drastically declined in Manitoba. Despite its small numbers, the population of *L. l. migrans* breeding in Ontario is considered to be a significant reservoir for the subspecies if numbers can be stabilized. The reproductive biology of the Loggerhead Shrike has been well studied in other portions of its range (Graber *et al.* 1973, Lohrer 1974, Porter *et al.* 1975, Anderson and Duzan 1978, Seigel 1980, Kridelbaugh 1983, Gawlick and Bildstein 1990, Tyler 1992). However, little is known about the breeding biology of the Loggerhead Shrike in Ontario. It is necessary to gain an understanding of the reproductive performance of the shrike in the critical Ontario population in order to determine how best to conserve the population in this area. Therefore, this study was

designed to determine the reproductive success of Loggerhead Shrikes in southern Ontario and to determine if reproductive success varied from one habitat type to another in order to assess the value of different habitat types to the species.

Study Area

Research into the reproductive performance of Loggerhead Shrikes breeding in Ontario was conducted at all active territories found during the breeding seasons of 1991 and 1992 in each of the 3 core areas in southeastern Ontario. Section 2 gives a more detailed description of their characteristics.

Methods

After a pair had been located, nests were found by following the flight paths of adults carrying nesting material or food. Areas where shrikes were sighted were checked frequently and the first nest found in each territory was considered to represent a first nesting attempt. The location of the nest in the nest tree was noted as being either touching a main trunk, supported by a main branch, in the centre of the canopy or at the edge of the canopy. The height from the ground to the bottom of the nest as well as the depth of the nest from rim to support was measured to the nearest cm. Nests were checked periodically to determine the timing of incubation, hatching and fledging as well as clutch size, hatching success (% of eggs laid that hatched), fledging success (% of young hatched that fledged) and nesting success (% of nests to fledge at least 1 young). Nest contents were observed with a mirror attached to a pole. The number of eggs or young was

recorded at each visit. When nests failed the area was examined for remains of eggshells or young and the condition of the nest was examined. Monitoring of sites continued after young had fledged to estimate the number of young surviving the 3 or 4 week period of dependence upon their parents. Fledglings vocalized when being fed by parents which aided in locating and determining the number of young present. However, fledglings were often inconspicuous and the number of fledglings may have been underestimated. Adults were observed for signs of renesting after a failed nesting attempt and/or double brooding throughout the season. Reproductive success was calculated using the Mayfield method (Mayfield 1975, Johnson 1979). Incubation was calculated as starting on the day when the next to last egg was laid and, for the purposes of backdating, hatching was considered to have occurred 17 days later. Although the hatching period normally lasts for 2 days for shrikes, the first day of hatching was considered as the last day of incubation. Nestlings were calculated as fledging at 19 days of age and fledging was considered to occur once the young left the nest, however they would often remain in the nest tree for 2 or 3 days before longer flights were attempted. The nesting success rates for red cedar (*Juniperus virginiana*), hawthorn (*Crataegus* spp.), hedgerow hawthorn and other species of nesting trees were then compared.

Comparisons of means using the Student's t-test for normally distributed populations and medians using the Mann-Whitney Rank Sum test for data that were not normally distributed were done with the

Sigmastat software package (SigmaStat 1992).

Results

Shrikes begin nesting in late April and early May in the northern part of their range. Incubation peaked in the second week of May in both 1991 and 1992 and the number of nests with nestlings was greatest in the first week of June. The majority of nests fledged young in the third week of June in 1991 and 1992. Later dates characterize renesting attempts or double brooding which was witnessed only occasionally in both 1991 and 1992 (Table 3.1). Some double brooding attempts may have been missed in either year as some nests were not found until later in the season and may have represented either renesting attempts or double brooding. Eighty-nine percent of all pairs observed in 1991 and 78% in 1992 were successful in fledging at least one young (Table 3.2).

The reproductive performance of Loggerhead Shrikes breeding in southern Ontario was high in both 1991 and 1992 (Table 3.3). In both years most of the eggs that were laid hatched and of those eggs that hatched, most of the nestlings survived to fledge. However, only about half of the young to fledge survived the three or four week period to independence. The number of eggs laid per nest and the number of eggs that hatched per nest was significantly different between 1991 and 1992 (Mann-Whitney U-test, $p < 0.05$), however, the number of fledglings and number of young to reach independence were not.

Two pairs renested after initially unsuccessful attempts in 1991 and one of these was known to have been successful. The fate

of the other is unknown. Eight pairs failed in first attempts in 1992 and 3 of these renested (38%), one of which was known to be successful. Renesting attempts could have been missed if attempted much later in the season than observations took place or if the pairs moved some distance before renesting. One of the failed nesting attempts in 1991 was believed to have been a result of the eggs being shaken out of the nest when a cow rubbed against the tree; the eggs were most likely eaten by a coyote (M. Paquin pers. comm.). The other was believed to have failed due to predation in 1991. In 1992, all clutches and broods that failed were believed to have been due to predation.

Double brooding was witnessed on one occasion in 1991 and 3 times in 1992. It was not possible to observe pairs which double brooded to determine if the attempt was successful as observations had been completed at the time.

The Mayfield method was used to determine the reproductive performance of Loggerhead Shrikes nesting in isolated red cedar, isolated hawthorn, hedgerow hawthorn and other species of trees (Tables 3.4 and 3.5). Four of 16 nests located in isolated red cedar trees failed during incubation. No failures were observed during incubation at nests located in isolated or hedgerow hawthorn trees or for nests in other species of tree. Daily nest survival was 98% for red cedar and 100% for isolated hawthorns, hedgerow hawthorns and for nests in other species of tree.

One nest of 12 in isolated red cedars and 4 of 24 nests in isolated hawthorns failed during the nestling period. No failures

occurred at nests in hedgerow hawthorns or other species of nesting tree in the nestling period. The probability of survival for any egg from the start of incubation until the young fledged was highest for nests located in other species of tree and lowest for nests in isolated red cedar nesting trees. Eggs in nests constructed in isolated hawthorn trees had a greater probability of survival than did nests made in isolated red cedar trees.

Nests were most often positioned touching the main trunk of red cedar and other species of nesting trees. Those nests constructed in hawthorn trees were most often positioned in the canopy centre, however, placement often occurred touching a main branch or trunk as well. Only one nest was positioned at the edge of the canopy and this occurred in a large ash tree where the nest was placed in a broken branch on the canopy edge (Table 3.6).

Discussion

Egg laying dates in Ontario have historically ranged from 1 April to 5 August (Peck and James 1987) and do not appear to have changed in recent years. Shrikes in southern Ontario began egg laying in late April and early May as has been reported for shrikes in the northern portion of their range (Miller 1931, Porter *et al.* 1975, Kridelbaugh 1983, Johns 1992). In the southern portion of their range shrikes will begin egg laying as early as February and March (Bent 1950, Graber *et al.* 1973, Porter *et al.* 1975, Seigel 1980, Gawlick and Bildstein 1990, Tyler 1992).

The number of Loggerhead Shrikes recorded breeding in southern Ontario almost doubled from 1991 to 1992, most likely as

a result of increased searching effort. The nesting success in both years was high and is consistent with reports of nesting success in other studies which range from 43% reported in Alabama (Seigel 1980) to 80% in Illinois (Graber et al. 1973). Brooks and Temple (1990) believed that values greater than 60% were more typical of Loggerhead Shrike nesting success as the lowest value of 43% was well below the second lowest value of 62% reported by Luukkonen (1987). The Loggerhead Shrike displays a greater than average reproductive success for an open cup nesting passerine breeding in a temperate zone (Ricklefs 1973, Nice 1975 and Brooks and Temple 1990).

The number of nests observed in both hedgerow hawthorns and other species of trees was quite low in comparison to the number in isolated hawthorn and red cedar trees. The probability of survival for a fledgling from an isolated hawthorn tree is much greater than that for one from an isolated red cedar tree. While hawthorn trees appear to be the more suitable for nesting based on reproductive success rates, only half of the Loggerhead Shrikes nesting in southern Ontario used them for nesting. This is most likely a result of the fact that half of the population is located in the Napanee plain area where red cedars are more prevalent. Personal communication with many landowners revealed the fact that red cedars have only begun to be common over the last 20 years. As well, they carry a fungus to which the hawthorn is susceptible (D. Cuddy pers. comm.) and many infected or dead hawthorns were found in this area.

Loggerhead shrikes were considered to be multibrooded by both Miller (1931) and Bent (1950), however, the extent to which shrikes are truly double brooded is in debate. Where weather conditions are favourable and the nesting season is long, shrikes are commonly double brooded (Miller 1931, Lohrer 1974). At higher latitudes the number of birds raising a second brood after an initial successful attempt declines (Porter *et al.* 1975). The first evidence of double brooding in southern Ontario was observed during this study (Pittaway 1993). There was no evidence of double brooding in Colorado (Porter *et al.* 1975). In Alabama, Seigel (1980) reported that 3 of 20 successful pairs renested and in Missouri Kridelbaugh (1983) found 7 of 38 successful pairs produced a successful second nest. Brooks and Temple (1990) reported that 5 of 48 pairs in Minnesota attempted to raise second broods, with 4 of them being successful and Tyler (1992) found that an overall average of 19.1% of the pairs in Oklahoma attempted second broods. In contrast, most authors agree that shrikes are extremely persistent breeders and will attempt to renest up to six times after a failure (Atkinson 1901, Miller 1931, Seigel 1980, Kridelbaugh 1983, Brooks and Temple 1990, Tyler 1992).

The clutch size (mean $\pm$ S.E.) and range found in this study (4.91 in 1991 and 5.56 in 1992 with a range of 4-7 eggs per clutch) resembles that reported in other studies: 4.38 in Florida (Lohrer 1974), 4.67 in Alberta (Johns 1992), 5.0 in Alabama (Seigel 1980), 5.4 in South Carolina (Gawlick and Bildstein 1990), 5.68 in Illinois (Graber *et al.* 1973), 5.58 in Minnesota (Brooks and Temple

1990), 6.3 in Manitoba (DeSmet 1990), 5.7-5.9 in Oklahoma (Tyler 1992) and 6.39 in Colorado (Porter *et al.* 1975).

Similarly, the number of mean number of young to hatch per nest in southern Ontario (4.20 in 1991 and 5.42 in 1992) was consistent with the findings of 5.08 in Colorado (Porter *et al.* 1975), 4.86 in Missouri (Kridelbaugh 1983), 4.18 in Minnesota (Brooks and Temple 1990) and 4.4 in South Carolina (Gawlick and Bildstein 1990).

The mean number of young to fledge per nest in this study was 3.90 in 1991 and 4.17 in 1992. Other studies have shown a success ranging from 3.0 in South Carolina (Gawlick and Bildstein 1990) to 3.57 in Colorado (Porter *et al.* 1975) which is slightly lower than what was found in southern Ontario.

This study attempted to follow young birds throughout this stage and found that while fledging success was very high (3.90 in 1991 and 4.17 in 1992), only half of the total number of young to leave the nest actually survived this period (2.30 in 1991 and 2.50 in 1992). Only one other study has reported on the number of young to survive the 3 or 4 week period required for young shrikes to become independent of their parents and of 3.96 young to fledge per successful nest, only 2.6 survived (Luukkonen 1987). Several authors have commented that shrikes appear to have high nesting success but believed that there may be high post-fledgling mortality. Therefore, a high reproductive output is required to maintain population numbers (Miller 1931, Graber *et al.* 1973, Cadman 1985). In western Canada, where banding of young has

occurred there has been a very low return rate: 3% reported in Manitoba (DeSmet 1990) and 5 of 546 young banded in Alberta (D. Collister pers. comm.). Brooks and Temple's (1990) model of the dynamics of a hypothetical Loggerhead Shrike population predicted the annual rate of juvenile survival to be 0.19 and the ratio of juvenile to adult survival to be 0.41. Using these figures, the model predicted a 20% mean annual rate of decline for the hypothetical Loggerhead Shrike population in Minnesota, which lends to a halving of the hypothetical population's size every 3.5 years.

The results of our study indicated a greater success in hawthorn trees than in red cedar consistent with the findings of Kridelbaugh (1983). In Alabama, shrikes that nested in red cedar trees and osage orange had a higher nesting success than did shrikes that nested in other tree species (Seigel 1980). In South Carolina shrikes that nested in red cedar fledged one more young per nest than did shrikes that nested in other tree species (Gawlick and Bildstein 1990). However, in Missouri shrikes that nested in red cedar had a lower nesting success than did those that nested in deciduous trees (Kridelbaugh 1983). In Virginia, nest success did not change with species of tree (Luukkonen 1987).

The present study found nest height to range from 2.07 m to 2.51 m, slightly lower than reported elsewhere, however Godfrey (1986) stated that nests are "from 1.5 to 1.6 m up in a tree or shrub". The average depth of the nest (11.23 to 12.4 cm) was in accord with Peck and James (1987) who reported outside depths of 7

to 12 cm. In South Carolina the average height of the nest was 4.4 m with the nest being closer to the trunk than the edge of the canopy (Gawlick and Bildstein 1990). Luukkonen (1987) found the average height of the nest to be 3.5 m for successful nests and 4.4 m for unsuccessful nest, while Kridelbaugh (1983) reported the average height of nest placement in Missouri to be 3.2 m.

Few differences exist between the reproductive performance and characteristics of Loggerhead Shrikes nesting in southern Ontario and those studied in other northern latitudes. While reproductive success appears to be high for all species of nesting tree, high post-fledging mortality may be affecting the population and warrants further study. The causes of mortality on the breeding grounds and the annual mortality rate of both juvenile and adult birds are required as well. Banding studies of this population would aid in understanding these factors and may give an indication of the degree of recruitment that occurs. The minimum viable population required to maintain the migrant shrike in Ontario must be determined. In addition, the annual rate of decline for this population based upon Brooks and Temple's (1990) model would help in determining the feasibility of the Recovery Team's goals. While protection of those birds that return to breed is fundamental to conserving the species, further study is required before management of the remaining shrike population in Ontario can be undertaken effectively.

Literature Cited

Anderson, D.W. and R.E. Duzan. 1978. DDE residues and eggshell

- thinning in Loggerhead Shrikes. Wilson Bull. 90:215-220
- Atkinson, W.L. 1901. Nesting habits of the California shrike *Lanius ludovicianus gambeli* Ridgw. Condor 3:9-11.
- Bent, A.C. 1950. Life histories of North American wagtails, shrikes, vireos and their allies. U.S. Natl. Mus. Bull. 197:114-182.
- Brooks, B.L. and S.A. Temple. 1990. Dynamics of a Loggerhead Shrike population in Minnesota. Wilson Bull. 102:441-450.
- Cadman, M.D. 1985. Status report on the Loggerhead Shrike (*Lanius ludovicianus*) in Canada. Draft report for the Committee on the Status of Endangered Wildlife in Canada.
- DeSmet, K. 1990. Manitoba's Endangered Grassland Birds Project. 1990 Summary and Highlights. Unpublished report.
- Gawlick, D.E. and K.L. Bildstein. 1990. Reproductive success and nesting habitat of Loggerhead shrikes in North-Central South Carolina. Wilson Bull. 102:37-48.
- Godfrey, W.E. 1986. The Birds of Canada. National Museum of Canada, Ottawa.
- Graber, R.R., J.W. Graber and E.L. Kirk. 1973. Illinois birds: Laniidae. Biol. Ser. No. 83. State of Illinois.
- Johns, B. 1992. Alberta Loggerhead Shrike Work. Can. Wildlf. Serv. Rep. Unpublished.
- Johnson, D.H. 1979. Estimating nest success: the Mayfield method and an alternative. Auk 96:651-661.
- Kridelbaugh, A. 1983. Nesting ecology of the Loggerhead Shrike in central Missouri. Wilson. Bull. 95:303-308.

- Lohrer, F.E. 1974. Post-hatching growth and development of the Loggerhead Shrike in Florida. M.Sc. thesis, Univ. South Florida, Tampa.
- Luukkonen, D.R. 1987. Status and breeding ecology of the loggerhead shrike in Virginia. M.Sc. thesis. Virginia Polytechnic Institute and State University, Blacksburg, Virginia.
- Mayfield, H. 1975. Suggestions for calculating nest success. Wilson Bull. 87:456-466.
- Miller, A.H. 1931. Systematic revision and natural history of the American shrikes (*Lanius*). Univ. Calif. Pubs. in Zool. 38(2): 11-242. University of California Press, Berkeley.
- Nice, N.M. 1957. Nesting success in altricial birds. Auk 74:305-321.
- Peck, G.K. and R.D. James. 1987. Breeding birds of Ontario, nidiology and distribution, Volume 2: Passerines. The Royal Ontario Museum, Toronto, Canada.
- Pittaway, R. 1993. Double-brooding in Ontario Loggerhead Shrikes. Ont. Birds. 11:69-70.
- Porter, D.K., M.S. Strong, J.B. Giezantanner and R.A. Ryder. 1975. Nest ecology, productivity and growth of the Loggerhead Shrike on the short grass prairie. Southwest Nat. 19:429-436.
- Ricklefs, R.E. 1973. Fecundity, mortality, and avian demography. Pages 366-447 in D.S. Farner, ed., Breeding biology of birds. National Academy of Sciences, Washington, D.C..
- Seigel, M.S. 1980. The nesting ecology and population dynamics of

the Loggerhead Shrike in the blackbelt of Alabama. M.Sc.
thesis, Univ. Alabama, Birmingham, Alabama.

SigmaStat for DOS User's Manual. 1992. Jandel Scientific. San
Rafael, California.

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

Table 3.1. Number of breeding pairs and nests found and percent of successful Loggerhead Shrikes breeding in southern Ontario in 1991 and 1992.

	1991	1992
No. pairs observed	27	50
No. nests found	27	40
No. successful pairs	24	39
Percent success	89	78

Table 3.2 Mean ($\pm$ S.E.) number of eggs, mode, range and total number of Loggerhead Shrike eggs observed in southern Ontario in 1991 and 1992.

	1991	1992
Mean	4.91 $\pm$ 0.14	5.56 $\pm$ 0.16
Mode	5	6
Range	4-6	4-7
Total # of eggs	39	104

Table 3.3. Summary (mean $\pm$ S.E.) of the reproductive effort of Loggerhead Shrikes breeding in southern Ontario in 1991 and 1992.

	1991	1992
No. eggs/nest	4.91 $\pm$ 0.14a	5.56 $\pm$ 0.16b
No. hatched/nest	4.20 $\pm$ 0.13c	5.42 $\pm$ 0.14d
No. fledged/nest	3.90 $\pm$ 0.28	4.17 $\pm$ 0.25
No. independent/pair	2.30 $\pm$ 0.02	2.50 $\pm$ 0.18

ab, cd statistically significant difference
(Mann-Whitney U-test, $p < 0.05$)

Table 3.4 Daily nest survival for any egg laid in isolated hawthorns, hedgerow hawthorns, isolated red cedars and other species of nest tree as calculated according to the Mayfield method (1975) for Loggerhead Shrikes breeding in southern Ontario during 1991 and 1992.

	No. days exposure exposure	No. nests failed	Daily nest survival
Isolated hawthorn (n=24)	188	0	100%
Hedgerow hawthorn (n=5)	85	0	100%
Isolated red cedar (n=16)	224	4	98%
Other species (n=5)	38	0	100%

Table 3.5 Probability of survival for any egg laid in isolated hawthorns, hedgerow hawthorns, isolated red cedar and other species of nest tree from the start of incubation until the young fledge as calculated according to the Mayfield method (1975) for Loggerhead Shrikes breeding in southern Ontario during 1991 and 1992.

	No. days exposure	Percent eggs hatched	No. nests failed	Daily nest survival
Isolated hawthorn (n=24)	358	94.39%	4	76.20%
Hedgerow hawthorn (n=5)	95	88.46%	0	88.46%
Isolated red cedar (n=12)	177	88.57%	1	58.56%
Other species (n=5)	77	92.86%	0	92.86%

Table 3.6. Mean ($\pm$ S.E.) depth (cm), height (m) in nest tree and placement (main trunk, MT; main branch, MB; canopy centre, CC; canopy edge, CE) of Loggerhead Shrike nests hawthorn, red cedar and other species of nest tree in southern Ontario during 1991 and 1992.

	Depth (cm)	Height (m)	Position			
			MT	MB	CB	CE
Hawthorn	11.23 $\pm$ 0.35	2.10 $\pm$ 0.13	32%	32%	36%	0%
Red cedar	11.30 $\pm$ 0.42	2.07 $\pm$ 0.15	63%	20%	17%	0%
Other species	12.4 $\pm$ 0.93	2.51 $\pm$ 0.52	49%	17%	17%	17%

Figure 3.1. Timing of reproduction by Loggerhead shrikes breeding in southern Ontario during 1991.

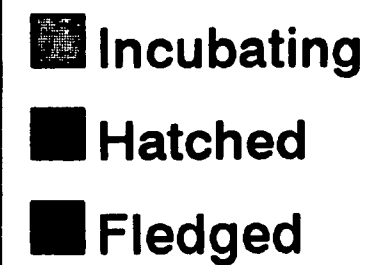
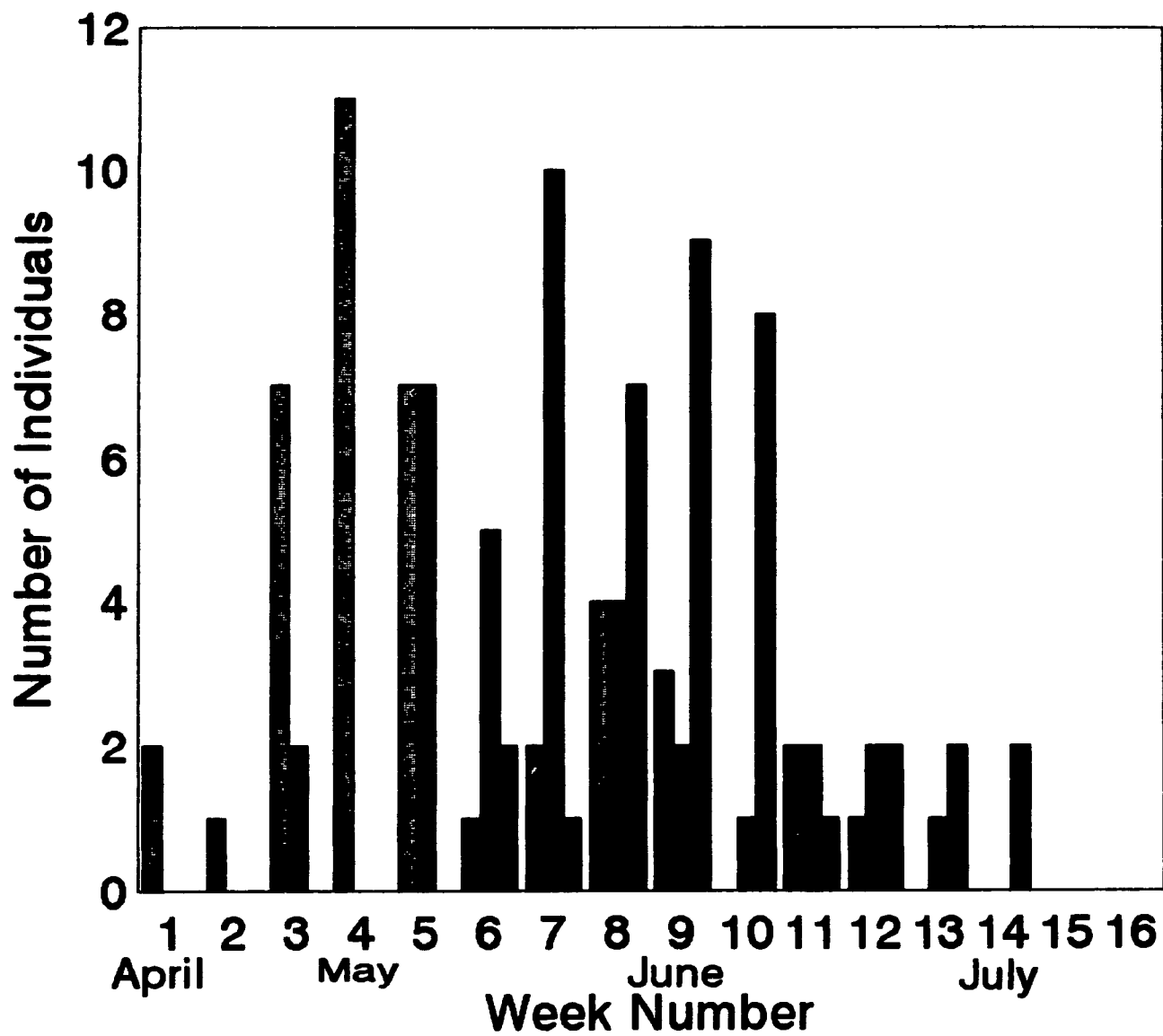
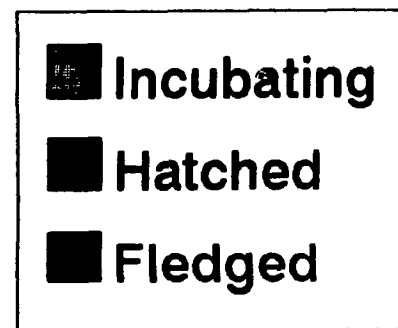
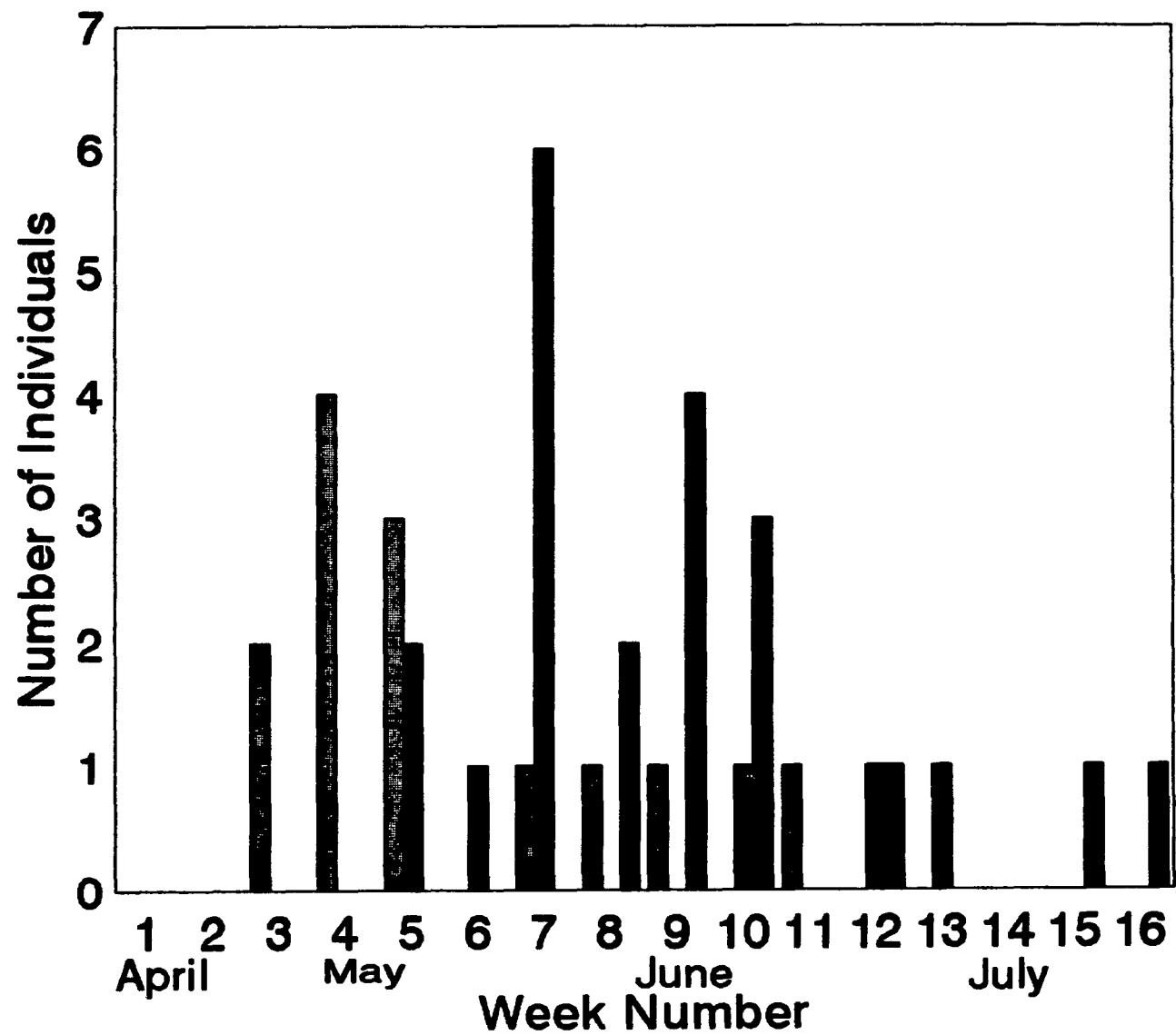


Figure 3.2. Timing of reproduction by Loggerhead Shrikes breeding in southern Ontario in 1992.



Connecting Statement

While the reproductive performance of the Loggerhead Shrikes breeding in southern Ontario appears to be relatively high. The population is still in decline. This would indicate that other factors are involved in the decline of the species. The investigation of the Loggerhead Shrikes utilization of habitat on their breeding grounds may help in understanding their requirements and the factors involved in the decline of the species. Section 5 will deal in more detail with the activity patterns of these birds during the reproductive cycle and the possible role of interspecific competition on the shrikes' reproductive performance.

SECTION 5:

HABITAT UTILIZATION BY LOGGERHEAD SHRIKES IN ONTARIO

A.A. Chabot, R.D. Titman and D.M. Bird

ABSTRACT

Loggerhead Shrike (*Lanius ludovicianus migrans*) behaviour was observed during the 1991 and 1992 breeding seasons in southern Ontario, Canada. The percentage of time birds spent in various activities was calculated for each of the major stages of the reproductive cycle. Shrikes spent between 81 and 92% of their time perched and observing their territory, between 2 and 7% hunting and 2 to 6% of their time changing perches. Other activities observed included preening (1-10%), calling (2-6%), nest building (13%), incubating eggs (93%), feeding mates (1-3%) or young (4-5%) and engaged in interspecific (1-6%) or intraspecific (0.45-4%) conflicts. The foraging rate was calculated to be between 9 and 14 attempts per hour with the greatest number of attempts occurring between 1800 and 2200h. The prey delivery rate was between 3 and 5 deliveries per hour with the greatest rate occurring from 1000 to 2000h. The avian fauna observed in association with Loggerhead Shrike nesting sites was noted and certain avian species were often found co-existing with shrikes.

Introduction

The Loggerhead Shrike (*Lanius ludovicianus*) breeds only in North America with 3 of the 11 subspecies commonly found in Canada. *L. l. migrans*, the migrant eastern subspecies, was once a fairly common breeder throughout its range, however, populations have declined steadily since the mid-1940's (Cadman 1985). As a result, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the shrike as "endangered" in 1991 and in

November, 1992 the species was classified as "endangered" by the province of Ontario. While several factors have been implicated in the decline of the species in both Canada and the United States (Cadman 1985), there appears to be a general consensus that habitat loss led to the slow reduction in numbers through the middle of the twentieth century in many parts of the species range (Bull 1974 and Kridelbaugh 1981). The continued widespread decline would suggest the involvement of other factors such as environmental contamination (Erdman 1970, Korschgen 1970, Campbell 1975, Busbee 1977, Anderson and Duzan 1978, Craig 1978, Kridelbaugh 1983), collisions with automobiles (Robertson 1930, Miller 1931, Bull 1974, Campbell 1975, Craig 1978), competition with heterospecifics including the American Kestrel (*Falco sparverius*), Eastern Kingbird (*Tyrannus tyrannus*) or Starling (*Sturnus vulgaris*) (Miller 1931, Bent 1950, Roest 1957, Campbell 1975, Hartley 1980, Cadman 1985), predation resulting in decreased nesting success (Porter et al. 1975, Seigel 1980, Kridelbaugh 1983) or adverse climatic trends affecting the shrike directly or through diminished prey availability (Peakall 1962, Bibby 1973). Research into the shrike's utilization of habitat and its interaction with avifauna within their territories increases our knowledge of the Loggerhead Shrike. In addition, data on habitat utilization will help to determine the affect of these factors upon the population of shrikes breeding in Ontario and aid in the successful conservation of the species.

Study Area

Habitat utilization by Loggerhead Shrikes was investigated on all active territories found during the breeding seasons of 1991 and 1992 in each of the 3 core breeding areas in Ontario. For a more detailed description of the location and characteristics of these study areas, refer to Section 2.

Methods

Once a breeding pair had been located they were observed for 1 to 2 hour periods every 2 to 3 days using a 20x spotting telescope and 8x or 10x binoculars. Adults were monitored continuously (Altmann 1974) to determine the percent of time spent hunting, flying, perched, feeding young or mates, preening, calling, nest building, incubating and engaged in interspecific or intraspecific interactions. The sex of Loggerhead Shrikes cannot be determined in the field by plumage, body shape or size. Therefore, observations were compiled grouping both sexes except during the incubation period when females were responsible for incubating the eggs and were fed by the male. All observations were dictated into hand held tape recorders and later transferred onto data sheets. The observation periods were distributed throughout the day and throughout the reproductive cycle in 1991 and 1992. It was assumed that shrikes were inactive during the night and therefore no observations were taken after dark. Observations were grouped into 4 hour blocks starting at 0600 h and ending at 2100 h in order to facilitate analysis of data concerning activity, hunting rate and prey delivery rate. The other bird

species commonly seen in the habitat and in particular, those birds the shrikes interacted with were also noted.

Results

A total of 218 hours was spent during 1991 and 1992 observing the breeding pairs of Loggerhead Shrikes in southern Ontario. The amount of time engaged in each of several activities during the various stages of reproduction was calculated (Table 4.1). Throughout their reproductive cycle both male and female shrikes spent the greatest amount of time perched (81%-92%), often on exposed branches in view of much of their territory.

The amount of time spent hunting never comprised more than 8% of the total time they were visible to the observer. The percentage of time foraging decreased during the laying and incubation period and increased to its highest rate during the fledgling stage. It decreased again during the 3 or 4 weeks that the fledglings were still dependent upon their parents. The amount of time shrikes spent changing perches increased until the fledgling stage was reached, when it reached its highest level (5.71%).

The rate of both preening and calling peaked during nest building (9.53% and 11.26%, respectively) and decreased markedly to the fledgling stage. Nest building was never seen to occupy more than an average of 13% of the shrike's time. There was great variation and some birds were observed to spend up to 20% of the 1 to 2 hour observation period engaged in nest building. The female spent an average of 93% of her time incubating the eggs, but left

for short periods of time to perch near the nest or hunt despite being fed by the male.

The male engaged in courtship feeding from the time of arrival of his mate, increasing the amount of time engaged in this activity during nest building. Males spent the greatest amount of time feeding their mates during incubation (3.52%), after which time all feeding of mates stopped and both sexes participated in feeding of the young. Up to 5% of the adults' time was spent feeding the nestlings and fledged young.

Male shrikes are known to be aggressive defenders of territories and both sexes were observed interacting with heterospecifics throughout the reproductive cycle. The amount of time engaged in encounters was initially high while shrikes were setting up territories. After a slight decrease, it continued to increase and peaked during the nestling stage. Interactions with other shrikes, namely mates and young, were observed on occasion and were greatest during the building of the nest and nestling stage.

The hunting rate was calculated for 4 hour increments throughout the day and according to the stage of reproduction (Table 4.2). Shrikes exhibited a high rate of foraging when first arriving and setting up territories. It then decreased to its lowest rate in the incubation period and subsequently increased. The greatest number of foraging trips was made between the hours of 1800 to 2200 h and the rate of foraging was lowest from 1400 to 1800 h.

Prey delivery was not seen on all occasions that foraging was observed, however, the rate of prey delivery could still be calculated in the same manner as the foraging rate (Table 4.3.). Prey delivery occurred during courtship and building of the nest and decreased during egg laying. The rate of prey delivery increased from incubation to the nestling stage and then decreased in most cases. The rate of prey delivery was greatest from the hours of 1000 to 1400 h and was lowest from 0600 to 1000 h.

While no attempt was made to catalog the diet of shrikes in Ontario, occasional observations revealed that the diet of the shrikes appeared to consist mainly of invertebrates, including grasshoppers (Orthoptera), crickets (Orthoptera) and dragonflies (Odonata) taken on the wing. Shrikes do have the ability to take vertebrate prey and impaled remains were observed on occasion. These items included the remains of an American Goldfinch, an unidentified sparrow and a small leopard frog.

Those bird species observed at Loggerhead Shrike nesting sites in southern Ontario were recorded for each of the 3 core areas (Table 4.4). Many species of birds are associated with habitat selected by shrikes during the breeding season. Many of the more common southern Ontario species can be seen at most shrike nesting sites. In addition, many species which are relatively rare on a widespread basis can be found fairly regularly in shrike habitat, including the Upland Sandpiper (*Bartramia longicauda*), Brown Thrasher (*Toxostoma rufum*), Eastern Bluebird (*Sialia sialis*) and Northern Mockingbird (*Mimus ployglottos*). Other bird species noted

within shrike sites are listed in Table 4.4.

The shrike is known to aggressively defend its territory and was found to interact with many of the species present (Table 4.5). The greatest number of interspecific interactions occurred with American Crows (*Corvus brachyrhynchos*), Brown Thrashers, American Kestrels (*Falco sparverius*) and American Robins (*Turdus migratorius*).

Discussion

The prey items observed in this study appears to be consistent with the findings of others in this area. Several researchers have studied the diet of shrikes and these accounts should be regarded as more complete than that found in the present study (Judd 1898, Beal and McAtee 1912, Miller 1931, Knowlton and Hamerstrom 1944, Bent 1950, Balda 1965, Ellison 1971, Chapman and Casto 1972, Graber et al. 1973, Craig 1974, 1978, Morrison 1980, Scott and Morrison 1990).

Very few studies have compiled time-activity budgets. The results of the present study, i.e. hunting and prey delivery rate, indicate that the amount of time shrikes spent perching, flying, changing perches, preening, chasing and the number of hunting attempts per hour are consistent with the findings of Yosef (1993) and Yosef and Grubb (1992).

During incubation, the hunting rate of shrikes in Ontario decreased considerably. This may be a result of decreased courtship feeding indicated by the decrease in the prey delivery rate during this period. The hunting rate subsequently increased

during incubation. The female is solely responsible for incubating the eggs and is fed by the male during this time, thus requiring an increased foraging effort by the male. Prey delivery decreased slightly and total time flying increased from the nestling to fledgling stage. This may indicate that males had to travel farther afield to obtain prey. The number of hunting trips per hour increased from the nestling to fledgling stage. Morrison (1980) found that the total movements of shrikes averaged considerably higher during the breeding season, adding to the energy expenditures of a hunting shrike and possibly placing constraints on the amount of hunting time available. Morrison (1980) also found that shrikes obtained more food during the breeding season by attacking prey more often and that their attack rate during the breeding season was twice that in the nonbreeding period. As well, the time between attacks decreased during breeding in response to greater food demands as was witnessed in the present study.

Both preening and calling peaked during the nest building stage and the rate of intraspecific interaction was at its second highest level. This may indicate that courtship was occurring, as ritualized preening, flutter displays and begging notes are all involved with courtship feeding (Miller 1931).

The amount of time engaged in interspecific conflict was initially high perhaps in response to the males' attempts to establish a territory (Smith 1973). It increased considerably throughout the breeding season to peak during the nestling stage.

When coupled with a high calling rate it indicates the vigour with which shrikes defend nest and nestlings. While several species were interacted with, none were seen engaged in activities harmful to the shrike. The high reproductive success experienced by shrikes may be due to a combination of the well insulated nest, the dense thorny nest tree which affords protection from predators and the aggressive parental protection.

Eastern Kingbirds (*Tyrannus tyrannus*) were present at most of the sites and shrikes were seen interacting with them on several occasions. While it has been suggested that kingbirds may compete with shrikes (Hartley 1980), no indication was given that the presence of kingbirds decreased the nesting success of shrikes at these sites. American Kestrels (*Falco sparverius*) were also observed regularly at shrike nesting sites and interactions between the two species did occur. While once believed to be a possible competitor with the Loggerhead Shrike due to apparent similarities in food and habitat requirements (Miller 1931, Bent 1950, Roest 1957, Campbell 1975), Gawlick (1988) found a niche separation of habitat between the two species. European Starlings (*Sturnus vulgaris*) were present at many of the sites and while Cadman (1985) suggested that they may impact upon shrikes, interactions between the two species were witnessed only occasionally.

Many potential species of avian predators were present at shrike nesting sites, including Northern Harriers (*Circus cyaneus*), several species of buteos, American Crows (*Corvus brachyrhynchos*) and Blue Jays (*Cyanocitta cristata*). Northern Harriers, American

Crows and Blue Jays were all witnessed in conflicts with shrikes. Predation has been implicated as a major cause of nest failure in shrikes in this and several studies (Porter et al. 1975, Seigel 1980, Kridelbaugh 1983) and approximately half of the young to fledge in this study may have been lost due to predation. Few researchers have actually witnessed predation upon adults or nestlings and research into this area could yield interesting results. In Alberta, D. Collister (pers. comm.) had evidence that a Brown Thrasher (*Toxostoma rufum*), commonly found at shrike nesting sites in southern Ontario, was responsible for the loss of three shrike nestlings. Crows are considered to be one of the main predators of Loggerhead Shrikes in Alberta (B. Johns, pers. comm.) and are also quite common at shrike nesting sites in Ontario. As well, Brown-headed Cowbirds (*Molothrus ater*) were found at several sites and interacted with shrikes on occasion. There are only three accounts of cowbirds parasitizing Loggerhead Shrikes (DeGeus 1991). Friedman (1929, 1963) speculated that the shrike's aggressive and predatory nature was responsible for the low incidence of parasitism by cowbirds.

The Loggerhead Shrike is a grassland species which is found in association with many other relatively rare species including the Northern Mockingbird, Brown Thrasher, Upland Sandpiper and Eastern Bluebird. Conservation attempts which preserve habitat for the Loggerhead Shrike will benefit these and other birds. While no apparent competition was observed between the shrike and any other species, further study is needed to understand the impact these

species have on the breeding success of shrikes. Additionally, no trends were witnessed in the shrike's utilization of habitat which would indicate that habitat quality is affecting the species. However, comparisons of the shrikes' use of habitat in this and other, stable populations may help in determining habitat quality.

Literature Cited

- Altmann, J. 1974. Observational study of behaviour: sampling methods. Behaviour XLIX:227-267.
- Anderson, D.W. and R.E. Duzan. 1978. DDE residues and eggshell thinning in Loggerhead Shrikes. Wilson Bull. 90:215-220
- Balda, R.P. 1965. Loggerhead Shrike kills mourning dove. Condor 67:359.
- Beal, F.E. L. and W.L. McAtee. 1912. Food of some well-known birds of forest, farm, and garden. U.S. Dept. Agric. Farmer's Bull. No. 506.
- Bent, A.C. 1950. Life histories of North American wagtails, shrikes, vireos and their allies. U.S. Natl. Mus. Bull. 197:114-182.
- Bibby, C. 1973. The red-backed shrike: A vanishing British species. Bird Study 20:103-110.
- Bull, J. 1974. Birds of New York State. Doubleday Natural History Press, New York.
- Busbee, E.L. 1977. The effects of dieldrin on the behaviour of young Loggerhead Shrikes. Auk 94:28-35.
- Cadman, M.D. 1985. Status report on the Loggerhead Shrike (*Lanius ludovicianus*) in Canada. Draft report for the Committee

- on the Status of Endangered Wildlife in Canada.
- Campbell, C. 1975. Distribution and breeding success of the Loggerhead Shrike in southern Ontario. Can. Wildl. Serv., Report No. 6055, unpublished.
- Chapman B.R. and S.D. Casto. 1972. Additional vertebrate prey of the Loggerhead Shrike. Wilson Bull. 84:496-497.
- Craig, R.B. 1974. An analysis of the predation by loggerhead shrikes (*Lanius ludovicianus gambeli* Ridjway). Unpublished Ph.D. Dissertation, Davis, Univ. Calif.
- Craig, R.B. 1978. An analysis of the predatory behaviour of the Loggerhead Shrike. Auk 95:221-234.
- DeGeus, D.W. 1991. Brown-headed Cowbirds parasitize Loggerhead Shrikes: first records for family Lanidae. Wilson Bull. 103:504-506.
- Ellison, L.N. 1971. Spruce grouse attacked by a northern shrike. Wilson Bull. 83:99-100.
- Erdman, T.C. 1970. Current migrant shrike status in Wisconsin. Passenger Pigeon. 35:144-150.
- Friedman, H. 1929. The cowbirds, a study in the biology of social parasites. C.C. Thomas, Springfield, Illinois.
- Friedman, H. 1963. Host relation of the parasitic cowbirds. U.S. Natl. Mus. Bull. 233.
- Gawlick, D. 1988. Reproductive success and nesting habitat of loggerhead shrikes and relative abundance, habitat use, perch use of loggerhead shrikes and American kestrels in South Carolina. M. Sc. thesis, Winthrop College, Rock

Hill, South Carolina.

- Graber, R.R., J.W. Graber and E.L. Kirk. 1973. Illinois birds: Laniidae. Biol. Ser. No. 83. State of Illinois.
- Hartley, R. 1980. Shrike strike. Blue Heron 24:13-14.
- Judd, S.D. 1898. The food of shrikes. U.S. Dept. of Agr. Bull. No. 9. Govt. Print. Off. Washington. 9:15-26.
- Knowlton, G.F. and F.C. Hamerstrom. 1944. Food of the white-rumped shrikes. Auk 61:642-643.
- Korschgen, L.J. 1970. Soil-food-chain-pesticide wildlife relationships in aldrin-treated fields. J. Wildl. Manage. 34:186-199.
- Kridelbaugh, A. 1981. Population trend, breeding and wintering distribution of loggerhead shrikes (*Lanius ludovicianus*) in Missouri. Trans. Miss. Acad. Sci. 15:111-119.
- Kridelbaugh, A. 1983. Nesting ecology of the Loggerhead Shrike in central Missouri. Wilson. Bull. 95:303-308.
- Miller, A.H. 1931. Systematic revision and natural history of the American shrikes (*Lanius*). Univ. Calif. Pubs. in Zool. 38:11-242. University of California Press, Berkeley.
- Morrison, M.L. 1980. Seasonal aspects of the predatory behaviour of Loggerhead Shrikes. Condor 82:296-300.
- Peakall, D.B. 1962. The past and present status of the red-backed shrike in Great Britain. Bird Study 9:198-216.
- Porter, D.K., M.S. Strong, J.B. Giezantanner and R.A. Ryder. 1975. Nest ecology, productivity and growth of the Loggerhead Shrike on the short grass prairie. Southwest Nat. 19:429-

- Robertson, J.M. 1930. Roads and birds. Condor 32:142-146.
- Roest, A.I. 1957. Notes on the American sparrow hawk. Auk 74:1-19.
- Scott, T.A. and M.L. Morrison. 1990. Natural history and management of the San Clemente Loggerhead Shrike. Proceedings of the Western Foundation of Vertebrate Zoology, Vol. 4, No.2.
- Seigel, M.S. 1980. The nesting ecology and population dynamics of the Loggerhead Shrike in the blackbelt of Alabama. M.Sc. thesis, Univ. Alabama, Birmingham, Alabama.
- Smith, S.M. 1973. An aggressive display and related behaviour in the Loggerhead Shrike. Auk 90:287-298.
- Yosef, R. Influence of observation posts on territory size of Northern Shrikes. Wilson Bull. 105:180-183.
- Yosef, R. and T.C. Grubb, Jr. 1992. Territory size influences nutritional condition in nonbreeding Loggerhead Shrikes (*Lanius ludovicianus*): A ptilochronology approach. Conserv. Biol. 6:447-449.

Table 4.1. Mean ($\pm$ S.E.) percentage of time breeding Loggerhead Shrikes in southern Ontario were observed engaged in various activities during 218 hours of observation in 1991 and 1992.

Reproductive stage	Perched	Hunting	Flying	Preening
Territory establishment	82.60 $\pm 2.66\%$	5.80 $\pm 1.60\%$	2.39 $\pm 0.61\%$	3.85 $\pm 2.08\%$
Nest building	81.92 $\pm 3.86\%$	6.14 $\pm 1.11\%$	3.50 $\pm 0.09\%$	9.53 $\pm 5.95\%$
Egg laying	91.88 $\pm 1.53\%$	3.14 $\pm 0.77\%$	4.55 $\pm 1.11\%$	1.13 $\pm 0.68\%$
Incubation				
Male	85.02 $\pm 1.71\%$	2.63 $\pm 0.31\%$	5.61 $\pm 0.73\%$	0.00 $\pm 0.00\%$
Female	28.33 $\pm 6.64\%$	0.94 $\pm 0.22\%$	0.95 $\pm 0.09\%$	0.00 $\pm 0.00\%$
Nesting	81.20 $\pm 1.39\%$	7.96 $\pm 0.80\%$	4.44 $\pm 0.63\%$	5.10 $\pm 0.66\%$
Fledgling	88.06 $\pm 1.22\%$	2.56 $\pm 0.26\%$	5.71 $\pm 0.64\%$	2.84 $\pm 1.82\%$

Table 4.1 cont'd. Mean ($\pm$ S.E.) percentage of time breeding Loggerhead Shrikes in southern Ontario were observed engaged in various activities during 218 hours of observation in 1991 and 1992.

Reproductive stage	Incubating	Nest Building	Feed Mate	Feed Young
Territory establishment	0.00 $\pm$ 0.00%	0.00 $\pm$ 0.00%	1.69 $\pm$ 0.73%	0.00 $\pm$ 0.00%
Nest building	0.00 $\pm$ 0.00%	12.59 $\pm$ 7.41%	2.94 $\pm$ 1.96%	0.00 $\pm$ 0.00%
Egg laying	0.00 $\pm$ 0.00%	0.00 $\pm$ 0.00%	1.20 $\pm$ 0.00%	0.00 $\pm$ 0.00%
Incubation				
Male	0.00 $\pm$ 0.71%	0.00 $\pm$ 0.00%	3.52 $\pm$ 0.96%	0.00 $\pm$ 0.00%
Female	92.51 $\pm$ 3.15%	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00%	0.00 $\pm$ 0.00%
Nesting	0.00 $\pm$ 0.00%	0.00 $\pm$ 0.00%	0.00 $\pm$ 0.00%	4.75 $\pm$ 0.61%
Fledgling	0.00 $\pm$ 0.00%	0.00 $\pm$ 0.00%	0.00 $\pm$ 0.00%	4.61 $\pm$ 0.72%

Table 4.1 cont'd. Mean ($\pm$ S.E.) percentage of time breeding Loggerhead Shrikes in southern Ontario were observed engaged in various activities during 218 hours of observation in 1991 and 1992.

Reproductive stage	Calling	Interspecific interactions	Intraspecific interactions
Territory establishment	4.99 $\pm$ 4.05%	2.18 $\pm$ 0.85%	0.00 $\pm$ 0.00%
Nest building	11.26 $\pm$ 0.00%	1.38 $\pm$ 0.81%	1.13 $\pm$ 0.00%
Egg laying	0.00 $\pm$ 0.00%	1.61 $\pm$ 0.59%	0.45 $\pm$ 0.00%
Incubation			
Male	0.00 $\pm$ 0.00%	3.56 $\pm$ 0.96%	0.00 $\pm$ 0.00%
Female	0.00 $\pm$ 0.00%	0.00 $\pm$ 0.00%	0.00 $\pm$ 0.00%
Nesting	5.18 $\pm$ 2.89%	5.39 $\pm$ 1.15%	3.48 $\pm$ 0.00%
Fledgling	2.86 $\pm$ 0.88%	1.80 $\pm$ 0.40%	1.04 $\pm$ 0.67%

Table 4.2. Hunting rate (mean $\pm$ S.E.) per hour during all stages of the reproductive cycle by Loggerhead Shrikes breeding in southern Ontario during 218 hours of observation in 1991 and 1992.

Reproductive stage	0600h-1000h	1000h-1400h	1400h-1800h	1800h-2200h
Courtship	10.00 $\pm$ 5.00	6.67 $\pm$ 2.91	15.50 $\pm$ 8.50	0.00 $\pm$ 0.00
Nest building	7.50 $\pm$ 2.50	6.00 $\pm$ 0.00	12.50 $\pm$ 5.85	6.00 $\pm$ 2.08
Egg laying	4.54 $\pm$ 1.50	4.00 $\pm$ 0.00	7.80 $\pm$ 2.58	0.00 $\pm$ 0.00
Incubation	9.00 $\pm$ 1.95	10.70 $\pm$ 2.26	9.00 $\pm$ 2.42	19.5 $\pm$ 1.50
Nestling	12.00 $\pm$ 1.86	12.22 $\pm$ 2.55	11.54 $\pm$ 3.24	9.00 $\pm$ 0.00
Fledgling	12.67 $\pm$ 3.83	10.46 $\pm$ 2.25	8.07 $\pm$ 1.80	19.7 $\pm$ 8.41

Table 4.3. Prey delivery rate (mean $\pm$ S.E.) per hour during all stages of the reproductive cycle by Loggerhead Shrikes breeding in southern Ontario during 218 hours of observation in 1991 and 1992.

Reproductive stage	0600h-1000h	1000h-1400h	1400h-1800h	1800h-2200h
Courtship	1.00 $\pm$ 0	0.00 $\pm$ 0.00	5.00 $\pm$ 0.00	0.00 $\pm$ 0.00
Nest building	1.00 $\pm$ 0	0.00 $\pm$ 0.00	6.00 $\pm$ 0.00	0.00 $\pm$ 0.00
Egg laying	1.00 $\pm$ 0	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00
Incubation	3.00 $\pm$ 1.00	4.00 $\pm$ 1.17	4.11 $\pm$ 0.95	1.50 $\pm$ 0.50
Nestling	4.30 $\pm$ 0.86	8.47 $\pm$ 2.60	4.36 $\pm$ 1.68	3.00 $\pm$ 0.00
Fledgling	4.80 $\pm$ 1.07	4.75 $\pm$ 1.21	3.40 $\pm$ 1.07	6.33 $\pm$ 1.76

Table 4.4. Frequency of associated bird species observed at Loggerhead Shrike nesting sites in the three core areas of breeding concentration in southern Ontario during 1991 and 1992.

Species	Carden plain	Napanee plain	Smith's Falls plain
Swans, Geese and Ducks (Family Anatidae):			
Geese (Subfamily Anserinae):			
Canada goose (<i>Branta canadensis</i>)	0	0	2
Marsh ducks (Subfamily Anatinae):			
Mallard (<i>Anas platyrhynchos</i>)	1	0	1
Blue-winged teal (<i>Anas discors</i>)	0	0	3
Gulls and Terns (Family Laridae):			
Ring-billed gull (<i>Larus delawarensis</i>)	1	3	1
Hérons and Bitterns (Family Ardeidae):			
Great blue heron (<i>Ardea herodias</i>)	2	1	3
Sandpipers and Phalaropes (Family Scolopacidae):			
Common snipe (<i>Capella gallinago</i>)	0	0	9
Upland sandpiper (<i>Bartramia longicauda</i>)	7	6	10
Plovers (Family Charadriidae):			
Killdeer (<i>Charadrius vociferus</i>)	6	4	17
Turkeys (Family Meleagrididae):			
Wild Turkey (<i>Meleagris gallopavo</i>)	0	1	1

Table 4.4 cont'd. Frequency of associated bird species observed at Loggerhead Shrike nesting sites in the three core areas of breeding concentration in southern Ontario during 1991 and 1992.

Species	Carden plain	Napanee plain	Smith's Falls plain
Hawks and Eagles (Family Accipitridae):			
Accipiters (Subfamily Accipitrinae):			
Cooper's hawk (<i>Accipiter cooperii</i>)	2	0	0
Harriers (Subfamily Circinae):			
Northern harrier (<i>Circus cyaneus</i>)	5	5	8
Buteos (Subfamily Buteoninae):			
Red-tailed hawk (<i>Buteo jamaicensis</i>)	5	4	3
Red-shouldered hawk (<i>Buteo lineatus</i>)	1	0	0
Browd-winged hawk (<i>Buteo platypterus</i>)	0	1	1
Falcons (Subfamily Falconinae):			
American kestrel (<i>Falco sparverius</i>)	1	6	7
American vultures (Family Cathartida):			
Turkey vulture (<i>Cathartes aura</i>)	5	4	2
Pigeons and Doves (Family Columbidae):			
Mourning dove (<i>Aeneida macroura</i>)	2	2	2
Cuckoos and allies (Family Caprimulgidae):			
Common nighthawk (<i>Chordeiles minor</i>)	1	0	0
Whip-poor-will (<i>Caprimulgus vociferus</i>)	1	0	0
Black-billed cuckoo (<i>Coccyzus erythrophthalmus</i>)	0	0	2

Table 4.4 cont'd. Frequency of associated bird species observed at Loggerhead Shrike nesting sites in the three core areas of breeding concentration in southern Ontario during 1991 and 1992.

Species	Carden plain	Napanee plain	Smith Falls plain
Woodpeckers (Family Picidae):			
Red-headed woodpecker (<i>Melanerpes erythrocephalus</i>)	2	0	0
Pileated woodpecker (<i>Dryocopys pileatus</i>)	0	0	1
Common ("Yellow-shafted") flicker (<i>Colaptes auratus</i>)	3	1	9
Downy woodpecker (<i>Picoides pubescens</i>)	1	1	0
Tyrant flycatchers (Family Tyrannidae):			
Eastern kingbird (<i>Tyrannus tyrannus</i>)	6	13	18
Great crested flycatcher (<i>Myiarchus crinitus</i>)	1	0	0
Larks (Family Alaudidae):			
Horned lark (<i>Eremophila alpestris</i>)	2	0	4
Swallows (Family Hirundinidae):			
Barn swallow (<i>Hirundo rustica</i>)	3	9	15
Tree swallow (<i>Iridoprocne bicolor</i>)	8	10	13
Crows and Jays (Family Corvidae):			
American crow (<i>Corvus brachyrhynchos</i>)	7	10	15
Blue jay (<i>Cyanocitta cristata</i>)	2	3	13

Table 4.4 cont'd. Frequency of associated bird species observed at Loggerhead Shrike nesting sites in the three core areas of breeding concentration in southern Ontario during 1991 and 1992.

Species	Carden plain	Napanee plain	Smith Falls plain
Titmice (Family Paridae):			
Black-capped chickadee (<i>Parus atricapillus</i>)	0	2	0
Wrens (Family Troglodytidae)	0	0	1
House wren (<i>Troglodytes aeden</i>)			
Mockingbirds and Thrashers (Family Mimidae):			
Brown thrasher (<i>Toxostoma rufum</i>)	6	7	16
Grey catbird (<i>Dumetella carolinensis</i>)	0	0	1
Northern mockingbird (<i>Mimus polyglottos</i>)	2	1	4
Thrushes (Family Turdidae):			
Eastern bluebird (<i>Sialia sialis</i>)	6	5	3
American robin (<i>Turdus migratorius</i>)	5	9	17
Waxwings (Family Bombycillidae):			
Cedar waxwing (<i>Bombycilla cedrorum</i>)	2	2	1
Wood warblers (Family Parulidae):			
Black-and-white warbler (<i>Minotilta varia</i>)	0	1	0
Bay breasted warbler (<i>Dendroica castanea</i>)	1	0	0
Yellow warbler (<i>Dendroica petechia</i>)	1	2	2
Common yellowthroat (<i>Geothlypis trichas</i>)	3	0	1

Table 4.4 cont'd. Frequency of associated bird species observed at Loggerhead Shrike nesting sites in the three core areas of breeding concentration in southern Ontario during 1991 and 1992.

Species	Carden plain	Napanee plain	Smith's Falls plain
Blackbirds and Orioles (Family Icteridae):			
Red-winged blackbird (<i>Agelaius phoeniceus</i>)	9	9	15
Brown-headed cowbird (<i>Molothrus ater</i>)	4	4	11
Common grackle (<i>Quiscalus quiscula</i>)	2	4	8
Bobolink (<i>Dolichonyx oryzivorus</i>)	8	5	17
Eastern meadowlark (<i>Sturnella magna</i>)	8	10	21
Western meadowlark (<i>Sturnella neglecta</i>)	1	0	0
Northern oriole (<i>Icterus galbula</i>)	3	4	3
Starlings (Family Sturnidae):			
European starling (<i>Sturnus vulgaris</i>)	8	4	16
Grosbeaks, Finches, Sparrows and Buntings (Family Fringillidae):			
Northern cardinal (<i>Cardinalis cardinals</i>)	1	1	0
American goldfinch (<i>Carduelis tristis</i>)	4	7	13
Rose-breasted grosbeak (<i>Pheucticus ludovicianus</i>)	1	0	0
Rufous-sided towhee (<i>Pipilo erythrophthalmus</i>)	1	0	0
Chipping sparrow (<i>Spizella passerina</i>)	3	3	6
Field sparrow (<i>Spizella pusilla</i>)	1	5	6
American tree sparrow (<i>Spizella arborea</i>)	0	5	3
Clay-colored sparrow (<i>Spizella pallida</i>)	0	1	0
Grasshopper sparrow (<i>Ammodramus savannarum</i>)	0	2	0
Song sparrow (<i>Melospiza melodia</i>)	2	5	8
Vesper sparrow (<i>Pooecetes gramineus</i>)	1	3	2
Savannah sparrow (<i>Passerculus sandwichensis</i>)	3	0	7

Table 4.5. Associated bird species observed engaged in aggressive interspecific interaction with Loggerhead Shrikes in southern Ontario during 1991 and 1992.

Species	No. Interactions
Herons and Bitterns (Family Ardeidae):	
Great blue heron (<i>Ardea herodias</i>)	1
Hawks and Eagles (Family Accipitridae):	
Harriers (Subfamily Circinae):	
Northern harrier (<i>Circus cyaneus</i>)	2
Falcons (Subfamily Falconinae):	
American kestrel (<i>Falco sparverius</i>)	3
Tyrant flycatchers (Family Tyrannidae):	
Eastern kingbird (<i>Tyrannus tyrannus</i>)	1
Swallows (Family Hirundinidae):	
Barn swallow (<i>Hirundo rustica</i>)	2
Crows and Jays (Family Corvidae):	
American crow (<i>Corvus brachyrhynchos</i>)	4
Blue jay (<i>Cyanocitta cristata</i>)	2
Mockingbirds and Thrashers (Family Mimidae):	
Brown thrasher (<i>Toxostoma rufum</i>)	4
Thrushes (Family Turdidae):	
American robin (<i>Turdus migratorius</i>)	3
Blackbirds and Orioles (Family Icteridae):	
Brown-headed cowbird (<i>Molothrus ater</i>)	2
Common grackle (<i>Quiscalus quisqualis</i>)	2
Bobolink (<i>Dolichonyx oryzivorus</i>)	1
Eastern meadowlark (<i>Sturnella magna</i>)	2
Starlings (Family Sturnidae):	
European starling (<i>Sturnus vulgaris</i>)	2

Connecting Statement

One of the greatest threats to wildlife today is habitat destruction. Unless there are sufficient places in which species such as the Loggerhead Shrike can live and reproduce, the high rate of extinction experienced today will continue. While extinction has always been a part of evolution, species today are being lost for different reasons and at a much faster rate. It is the our responsibility as we create changes in the environment and global biodiversity to limit the deleterious effects of our actions and whenever possible, to conserve the diversity of life found around us. In order for conservation efforts to be effective, the needs of the species must be understood and acted upon. Each species is unique and the more we can learn about their needs, the more effective we can be in protecting them.

SECTION 6:

CONCLUSION AND MANAGEMENT SUGGESTIONS

CONCLUSIONS

The number of Ontario Breeding Bird Atlas squares found to support breeding pairs of Loggerhead Shrikes has continued to decline since the 5 year atlas period of 1981-1985. With just over fifty pairs of breeding Loggerhead Shrikes in all of southern Ontario and two pairs in Quebec, the Ontario population is an important reserve for the eastern subspecies of Loggerhead Shrike. Visually suitable habitat can be found in each of the three core areas in southern Ontario and many historic sites are reoccupied. However, it appears that the amount of habitat around sites may influence site selection.

The Loggerhead Shrikes breeding in southern Ontario begin egg laying in late April and early March, shortly after returning to their breeding territories and the start of incubation peaks in the second week of May. Shrikes are persistent breeders in southern Ontario and will attempt several renests if needed before raising a successful brood. Evidence of double brooding was found in this population, but it is not a common occurrence. The average clutch size of shrikes breeding in Ontario is similar to that of shrikes breeding in other areas in northern latitudes. They experience a comparatively high rate of reproductive success, however the number of young to reach the stage at which they are independent from their parents is only approximately half of those young which fledge, indicating post-fledgling mortality may be an important factor in the species' decline. Loggerhead Shrikes in Ontario most often nested in isolated trees

located in actively grazed pastures. Nest placement is most often next to the main trunk of the nest tree or shrub, usually a red cedar or hawthorn. However, some shrikes did select other species and nests were occasionally located in hedgerows.

Loggerhead Shrikes appear to randomly select nesting sites within a territory, however the nest site selection itself appears to be influenced by the amount of suitable habitat around the site, thus creating pockets of concentration of breeding shrikes. The suitability of sites based upon a shrike's ability to forage from a perch is significantly different when the amount of unusable habitat is considered. This may also affect the suitability of a site.

A variety of other bird species, including many relatively rare species, co-exist within active Loggerhead Shrike territories. Interactions between shrikes and a variety of these birds was witnessed, but no direct evidence of their impact upon the nesting success of Loggerhead Shrikes was observed. Shrikes spent a great amount of time perched and observing their territory. Their rate of hunting and prey delivery increased throughout their nesting cycle as the demands made by mates and young increased.

MANAGEMENT SUGGESTIONS

The National Loggerhead Shrike Recovery Team in Canada has set a goal of maintaining or enhancing wild populations of Loggerhead Shrikes nesting in Canada to the point where

populations are stabilized at a level permitting the removal of their threatened or endangered status by the Committee on the Status of Endangered Wildlife in Canada. However, before this goal can be met, many steps will be required to better understand the cause of decline and the measures required to reverse this trend. The results of this study and previous surveys have emphasized that the population of Loggerhead Shrikes which breeds in Ontario is the remaining reservoir in the east. The population must also be evaluated in terms of the minimum viable population size required to maintain the genetic diversity of the eastern subspecies and to assess the need for more aggressive conservation needs such as captive breeding.

Research into the causes of decline must continue and should be geared specifically to the determination of toxic chemical levels found in all stages of shrikes, the impact of road-kills on population numbers, the impact of heterospecific species on shrike nesting success and survival, the extent of juvenile mortality and site fidelity. As well, further investigation into the effect of land use changes on the historic nesting sites of shrikes in southern Ontario and Quebec is required. The effect of these changes on the status and trend of shrikes should prove to be interesting and would perhaps give more indication as to the cause of decline of the species in eastern Canada.

Habitat protection did not appear necessary when it was believed that there was much available habitat unoccupied. However, the results of this study indicate that habitat

fragmentation plays a more important role than previously understood. Therefore, not only must active nesting sites be protected, but large tracts of contiguous land need to be preserved as well. The amount of available habitat should be reassessed, taking into consideration the effect of habitat fragmentation on site suitability and choice. If population levels are to be increased, habitat restoration will need to be undertaken. When the high reoccupancy rate of historic and recent breeding sites is considered, efforts should be concentrated around these sites. Restoration efforts should be undertaken with the set goal determined by the amount and quality of habitat required to support a population larger than the minimum viable population.

Annual surveys to monitor population status and distribution should continue and banding of the population should be attempted. The results of banding studies should give some indication of site fidelity and the importance of the historic sites can then be better assessed. Additionally, information concerning the wintering location, changes to habitat in these areas and mortality rate on the wintering grounds is imperative. Cooperation with United States agencies, biologists and amateur birdwatchers will help in undertaking these efforts. Unless efforts on the breeding grounds can be matched on the wintering grounds, the population decline will most likely continue.

The Loggerhead Shrike is becoming one of the more well known grassland species of birds, however, many other relatively rare

species of birds co-exist with the shrike and efforts to conserve habitat for the shrike would mostly likely benefit these species as well. Habitat management guidelines should be written for the shrike and would be most valuable through a community approach to conservation. These guidelines should outline ways in which habitat can be maintained or created (e.g. by addition of perches or thinning of shrubs in areas where succession is taking over). Implementation of the measures should be coupled with studies assessing the effectiveness of these activities.

The plight and status of the Loggerhead Shrike must be publicized, however the secrecy about nest site locations must be maintained. Educational material for distribution to landowners with nesting shrikes on their property and interested conservation and naturalist groups should be produced. The participation of landowners and naturalist groups should be encouraged and the protection of nesting sites through incentive programs should be encouraged. In order to make the conservation of the Loggerhead Shrike and other species in a similar predicaments a successful effort, we must first understand the unique qualities and needs of the species and guide our efforts accordingly.