Nocturnal field use by wintering Skylark Alauda arvensis on intensive farmlands

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NOCTURNAL FIELD USE BY WINTERING SKYLARK *ALAUDA ARVENSIS* ON INTENSIVE FARMLANDS

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RÉSUMÉ

Peu de travaux abordent l'écologie de l'Alouette des champs (*Alauda arvensis*) en hiver et ceux disponibles ont trait au régime alimentaire ou à l'occupation diurne de l'espace agricole. Cet article présente des données originales sur l'utilisation nocturne des parcelles par les oiseaux hivernants dans les plaines cultivées de l'Ouest de la France. Au cours de l'hiver 2000-2001, l'abondance des alouettes et la taille des groupes ont été estimées pour 119 parcelles de cultures à l'aide d'un phare portatif et selon la méthodologie des transects linéaires. Dans chaque parcelle, nous avons enregistré les variables relatives au type de culture (chaumes, céréales d'hiver, ray-grass, jachères, légumineuses, colza, terre nue), à la hauteur et au recouvrement de la végétation. Nous avons utilisé des modèles linéaires généralisés pour tester l'effet de ces variables sur l'abondance de l'Alouette des champs. 458 alouettes ont été dénombrées sur un total de 42,42 km de transect. Les résultats de l'analyse soulignent un effet significatif du type de culture, de la hauteur et du recouvrement de la végétation sur l'abondance des oiseaux. Les Alouettes des champs étaient plus abondantes sur les parcelles de chaumes, lorsque la hauteur de végétation était comprise entre 1 et 10 cm et lorsque le recouvrement de la végétation était compris entre 10 et 75 %. Les parcelles dénuées de végétation étaient évitées. Nous n'avons contacté aucun groupe d'alouettes de grande taille. 41,7 % des contacts ne concernaient qu'un seul oiseau et seulement 5,1 % étaient des groupes constitués de plus de 10 oiseaux. L'ensemble de ces résultats sont discutés à la lumière des connaissances actuelles sur l'utilisation diurne de l'espace agricole et le comportement nocturne des alouettes.

SUMMARY

Few studies investigate ecological requirements of wintering Skylark *Alauda arvensis*, most dealing with diet or diurnal field occupancy. This paper presents original data about the nocturnal field use by wintering Skylarks on intensive farmlands in western France. In December 2000 and January 2001, bird abundance and flock size were estimated in 119 fields using the line transect method and a 100 watts searchlight. In each field, variables such as crop type, vegetation height and ground cover were recorded. Crop types included stubbles,

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winter cereals, ryegrass, set-aside, legumes, oilseed rape and bare ground. We used General Linear Models with Poisson error term to fit models describing skylark abundance according to these variables. 458 Skylarks were counted along 42.42 km. Results showed significant effects of crop type, vegetation height and ground cover on abundance of birds. Skylarks were more abundant in stubble fields. When considering all crop types, skylarks were more abundant where vegetation height ranged from 1 to 10 cm and ground cover from 10 to 75%. Fields without vegetation were avoided. Large flocks were never recorded. 47.1% of the contacts were single birds and 5.1% were flocks of more than 10 birds. These results are discussed in relation to present knowledge of the diurnal field use and nocturnal flocking behaviour.

INTRODUCTION

French Skylark *Alauda arvensis* populations are of conservation concern since the late 1970's (Vansteenwegen, 1998; Boutin *et al.*, 2001). According to Chamberlain *et al.* (2000), the populations decline is likely to be due to changes in agricultural practices implying switches in crop composition, reduction in crop diversity and increase in pesticides inputs. Numerous studies underline their negative effects on population growth rate by reducing breeding attempts, breeding success and invertebrate preys availability (Schläpfer, 1988; Jenny, 1990; Campbell *et al.*, 1997; Wilson *et al.*, 1997; Chamberlain *et al.*, 2000). Nevertheless, this explanation is not exclusive since other demographic parameters such as a decreasing winter survival rate could be involved (Chamberlain & Crick, 1999). In this way, Wolfenden & Peach (2001) suggest that the loss of winter ground quality, particularly a reduction in food availability, could reduce survival and recruitment rates. Although the conditions encountered by skylarks on their wintering grounds seem important, few ecological studies were carried out during this period.

Lowland arable farmland is the most important habitat for migratory and wintering skylarks (Gillings, 2001). Because of shift from spring cereals to winter cereals, cereal stubbles were reduced in this area. Previous works show that granivorous birds avoid winter cereal sowings and bare grounds (Evans & Smith, 1994; Wilson *et al.*, 1996; Henderson & Evans, 2000). In opposite, cereal stubbles are suggested as an important food supply for skylarks and for other granivorous species by providing high densities of grain which is a valuable diet component (Green, 1978; Wilson *et al.*, 1996; Donald *et al.*, 2001). For these reasons, Cirl Bunting *Emberiza cirlus* could have declined in Britain following the general reduction in cereal stubble areas (Evans & Smith, 1994).

Nevertheless all studies showing that stubbles are an important requirement for wintering birds, address diet or diurnal field occupancy analysis. On another hand, knowledges about nocturnal requirements in Skylark are scarce (*see* Cramp *et al.,* 1988), even though suitable roosting site availability could be a key factor in the choice for wintering grounds by this species. In this paper, we present original data on the nocturnal field use by wintering Skylark. In particular, we investigate the hypothesis that stubbles provide more suitable roosting sites than winter cereal sowings and bare grounds as suggested by Labitte (1937). In addition, the influence of vegetation characteristics (height and cover) on the abundance of roosting birds was assessed.

MATERIAL AND METHOD

Study area, bird and habitat data

The study was carried out in southern Deux-Sèvres (Western France) on intensive farmlands during the 2000/2001 winter (from 15th December 2000 to 20th January 2001). Abundance of Skylark was estimated for 119 independent fields using the line transect method (Bibby *et al.*, 1992). Only one transect per field was carried out. Birds were censused between 20:00 and 22:30 by an observer walking along a straight line across field, using a 100 watts searchlight and a portable battery. Flushing birds were counted on each side of the line transect. To standardize the illuminated area, the beam was trained at 30 meters from the observer, assuming an equal transect width for each transect. Counts were made under good weather conditions (no rain or no wind > 3 on Beaufort scale). For each field, abundance of Skylark was estimated per 100 m using the ratio of the number of birds counted and the transect length. Birds which took off and flock size were recorded and plotted on a 1/4,000 map. We defined a flock as birds within 50 m from each other. The 119 transects totalled 42.42 km. Mean transect length (± SE) was 338.50 m (± 14.79). The day before counting, vegetation height and cover were measured for each field using 10 equidistant points on a diagonal transect across field. Vegetation height (in cm) was assigned to the following 4 categories: (0), (1 – < 10), (10 – < 20), (≥ 20). Vegetation cover (in %) was assigned to the following 5 categories: (< 10), (10 – < 25), (25 – < 50), (50 – < 75), (≥ 75). Crop types included winter cereals, stubbles (cereals, maize, sunflower), oilseed rape, permanent set-aside (naturally regenerating or sown with rye grass and clover), legumes (lucerne and clover), ryegrass and bare ground (recently sown and ploughed fields).

Statistical analysis

Skylark abundance in relation to crop type, vegetation height and cover categories was modelled using generalized linear models implemented in GLIM software. The model fitted to bird counts was as follows:

$$\text{Ln}\ [\text{E}(\text{Skylark}_{ijk})] = I + C_i + H_j + R_k + \alpha_{ijk} + \varepsilon_{ijk},$$

where E(Skylark) = expected number of birds on a line transect; I = intercept term; C_i = crop type i (with i = one of 7 crop types defined above); H_j = vegetation height category j (with j = one of 4 height categories defined above); R_k = cover category k (with k = one of 5 cover categories defined above); α_{ijk} = Ln(length of transect line $_{ijk}$ in meter) fitted as an offset to control for transect length; ε_{ijk} = Poisson error term.

According to GLIM procedure, the comparison within a categorical factor is relative to a given category level (null category). For crop type, vegetation height and cover categories, the null categories were respectively winter cereals, (0 cm) and (< 10%). Model estimates for these null categories were set at zero. A forward stepwise procedure was used to select the model which fitted the best the data. At each step, a factor was separately added into the model and difference from the previous model was tested using deviance statistics and likelihood ratio test (at $P \leq 0.05$). The final model included all significant factors and the best fit. Overdispersion was taken into account in deviance and standard deviation estimates. For a given factor, model estimates for each category were compared to the null category using likelihood ratio test (at $P \leq 0.05$).

Other statistical analyses were carried out using non-parametric tests.

RESULTS

Vegetation characteristics

Vegetation height and cover differed significantly among crop types (respectively, Kruskal-Wallis = 82.43, df = 6, $P < 0.0005$ and Kruskall-Wallis = 81.47, df = 6, $P < 0.0005$). Median categories calculated by crop types for vegetation height and vegetation cover are shown in Table I. The vegetation height was the lowest in winter cereal and stubble fields and was the highest in set-aside, legumes and ryegrass. Vegetation cover increased from winter cereal to oilseed rape and ryegrass fields.

TABLE I

Detail of line transect samplings, vegetation characteristics and bird counts by crop type

	Winter cereals	Stubbles	Oilseed rape	Set-aside	Legumes	Ryegrass	Bare ground	Overall
Line transect								
n	41	19	16	4	8	6	25	119
Length (km)	17.233	6.309	5. 926	9.753	2.407	1. 999	7.575	42. 423
%	40.62	14.87	13.97	2.30	5.67	4.71	17.86	-
Vegetation								
Median height class	2.00	2.00	3.00	3.50	3.50	4.00	1.00	
Median cover class	2.00	3.00	3.50	3.00	3.00	5.00	1.00	
Bird count								
n	184	175	43	5	33	15	3	458
%	40.17	38.21	9.39	1.09	7.21	3.28	0.66	-
Mean flock size	2.39	3.80	3.07	1.25	4.13	2.50	1.50	2.92
SE	0.28	0.57	1.01	0.25	1.19	0.76	0.50	0.25

Flock size

458 skylarks were counted, giving a ratio of 1.08 birds × 100 m^{-1}. Most contacts concerned only single birds (47.13%) or flocks of 2-3 birds (26.75%). Few flocks comprised more than 10 birds (5.09%), the largest one had 19 birds. Flock size did not differ significantly (Kruskal-Wallis = 10, 44 *df* = 6, $P = 0.107$) among crop types. However, we noticed that flock size was higher in stubble fields than in other crop types (Mann-Withney, $\chi^2 = 5.63$ *df* = 1, $P = 0.018$) but difference was slight (respectively medians = 3 and 1).

Abundance

More than 78% of birds were recorded in winter cereals and stubbles. Model selection showed that each environmental factor had a significant effect on Skylark's abundance (Table II). Also for further purpose, the full model was simplified

Table II

Results of Poisson regression models relating nocturnal abundance of Skylark in field. Models include a crop type effect (C), a vegetation height effect (H) and a vegetation cover effect (R). P is the significance for change in deviance with additional effect according to Likelihood Ratio Tests. For each effect, the number of categories is given as (i, j, k) = n

Model	Deviance	df	P
[Intercept]	198.49	118	-
[Intercept + $C_{i=7}$]	131.45	112	< 0.00001
[Intercept + $C_{i=7}$ + $H_{j=4}$]	117.31	110	0.00085
[Intercept + $C_{i=7}$ + $H_{j=4}$ + $R_{k=3}$] (1)	105.15	108	0.0023
[Intercept + $C_{i=7}$ + $H_{j=4}$ + $R_{k=5}$]	104.94	106	0.90

(1) For vegetation cover, categories are pooled as following: (< 10%), (10 < 25% = 25 < 50% = 50 < 75%) and (> 75%).

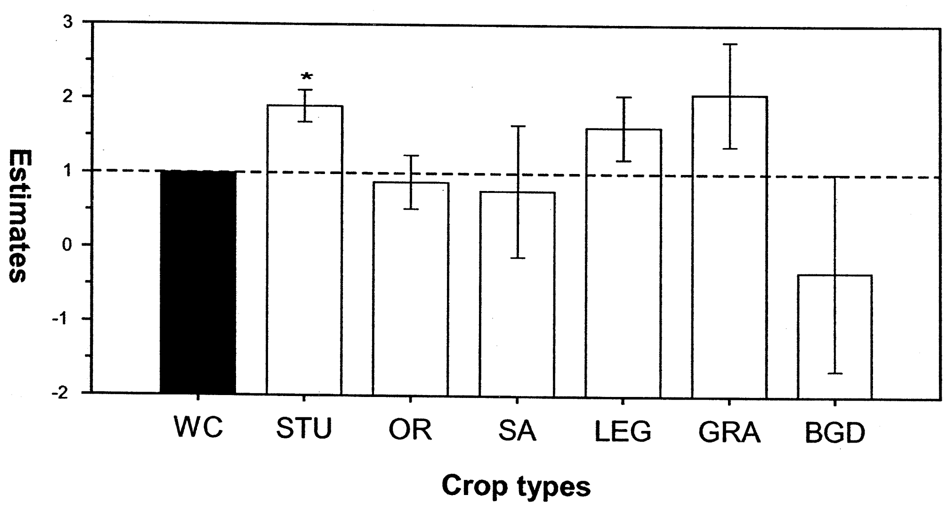

Figure 1. — Model estimates for the abundance of Skylark in relation to crop type. Estimates and hypothesis test (* $P < 0.05$) are relative to a null category (WC) for which the parameter is set at zero for calculation, but at one in this figure (----). (WC) winter cereals, (STU) stubbles, (OR) oilseed rape, (SA) set-aside, (LEG) legumes, (GRA) Ryegrass, (BGD) bare ground. Errors bars show standard deviations.

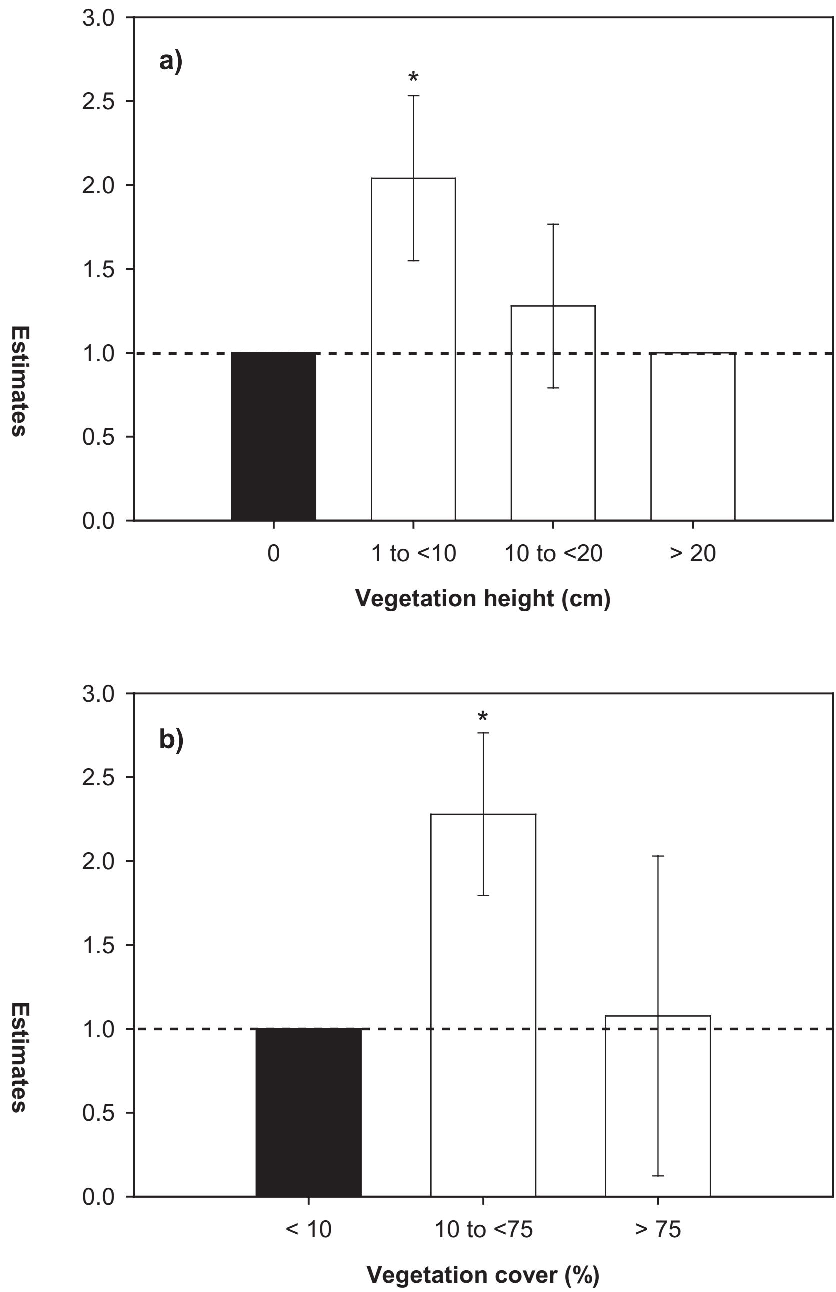

Figure 2. — Model estimates for the abundance of Skylark in relation to the effects of (a) vegetation height category and (b) vegetation cover category. Estimates and hypothesis test (* $P < 0.05$) are relative to a null category (0 cm and < 10 % respectively) for which the parameter is set at zero for calculation, but at one in this figure (----). Error bars show standard deviations.

by reducing the number of categories for vegetation height and cover factors. In the final model, the vegetation height factor was reduced at three categories without a significant loss in model fit. These categories were the followings: [< 10%], [10 – < 75%] and [≥ 75%]. Model estimates by crop type, vegetation height and cover categories are given in Figures 1 and 2. Skylark abundance was significantly higher in stubbles relative to winter cereals (null category). The lowest abundance was recorded in bare ground, but the difference from the null category was not significant. Furthermore, abundance of Skylark was the highest when vegetation height ranged from 1 to 10 cm. There were no significant differences between fields without vegetation (null category) and fields with a vegetation height of more than 20 cm. When considering vegetation cover, the abundance of Skylark was significantly higher in 10-75% category than < 10% category (null category). When vegetation cover was more than 75%, abundance of birds did not differ significantly from the null category.

DISCUSSION

Habitat use

Skylarks roost over wide range of crop types. However, our results show that stubbles support slightly higher birds density than other crop types. Interestingly, our results suggest that skylarks use similar crop types when roosting at night, as they do when foraging the day. Highest diurnal densities of skylarks are consistently recorded in stubble fields (Wilson *et al*., 1996; Wakeham-Dawson & Aebischer, 1998; Buckingham *et al*., 1999; Donald *et al*., 2001; Robinson, 2001; Vickery & Buckingham, 2001), then lowest densities are found in winter cereal sowings and bare grounds (Wilson *et al.,* 1996; Thomsen *et al.,* 2001, Vickery & Buckingham, 2001). In the same way, Donald *et al*. (2001) suggest that non-rotational set-asides are less used than rotational set-aside. In our study area, all set-asides were non-rotational. According to Wakeham-Dawson & Aebischer (1998) the abundance of Skylark is positively related to the abundance of seeds which are the main diet component in winter. So, whereas the preference for stubbles is likely related to the high density of grain they provide to feeding birds, the important use of stubble fields by roosting birds remains unclear because vegetation characteristics are similar to other crop types (Table I) and skylarks do not feed at night. One hypothesis is that few birds redistribute at night, the most roosting in the same field used during the day. Future investigations should compare counts carried out in the same fields during the day with those at night.

In our study, the density of roosting skylarks was highest in fields with a vegetation height below 20 cm and a vegetation cover below 75%. Again, this result suggests that skylarks use similar combinations of vegetation height and cover when roosting at night, as they do when foraging the day. Wakeham-Dawson & Aebischer (1998) show that skylarks tend to forage in fields with low cover ground and with a vegetation height ranging from 10 to 20 cm. So, there is evidence that a sward vegetation could limit locomotion of birds, but this effect can not account for the low use of bare grounds. A complementary hypothesis is that vegetation is needed to protect birds from wind and consequently to reduce or maintain the energy cost of thermoregulation. The works conducted on Alaudidae species and reviewed by Cramp *et al*. (1988) are in accordance with this hypothesis. In Shore Larks (*Eremophila alpestris*) birds prefer roosting in field protected from prevailing winds, and in Black Lark (*Melanocorypha yeltonensis*) birds roost in a sward cover when climatic conditions are worst. This latter result could explain the use of field with high cover ground such as ryegrass. Additionally, field orientation from dominant winds could also be an important factor and should be investigated further in studies dealing with roosting site selectivity.

Flock size

According to many authors, Skylark and other Alaudidae species roost at night in large flocks (reviewed by Cramp *et al.,* 1988). Our data do not confirm such a pattern since less than 5% of the flocks were of 10 birds or more. The explanation of this result remains unclear even though a similar pattern was found in White-winged Lark (*Melanocorypha leucoptera*). First, if birds roost in large flocks and over restricted areas, we may have missed some flocks because of inadequate sampling effort or counting method. Although we cannot reject the difficulty of being certain of flock size when counting birds in the beam, it is unlikely that we have missed many birds because we used a powerful searchlight which allowed us to detect birds flushing beyond line transect limits. Second, the status of single birds was unknown. These birds could be residents displaying a flocking behaviour different from that of migratory birds. Finally, Skylark dispersal within field at night could correspond to a strategy against predation risk where high bird dispersal could reduce their detection.

CONCLUSION

What field type should conservationists maintain in winter in order to favour both feeding and roosting birds? Our results suggest that stubble fields are key habitats for conservation issue because they provide an important food supply (Green, 1978; Wilson *et al*., 1996; Donald *et al*., 2001) and they are also suitable roosting sites. Therefore, the retention of stubble fields should be encouraged in order to favour wintering skylarks. This retention should increase stubble areas but also maintain them over a longer period throughout the winter, contrasting with the modern agricultural practices currently used.

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