Winter feeding of the Crane in cereal farmland at Gallocanta, Spain

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Introduction

Over the last decade Cranes *Grus grus* have been increasingly using the Laguna de Gallocanta (NE Spain) as a staging area during both postnuptial and prenuptial migrations as well as in winter (Alonso *et al.* 1983a; Veiga *et al.* 1983). Probable reasons for this have been: a) the strategic situation of the zone within the migration corridor of the species; b) the presence of a shallow lake with suitable roosting sites in close proximity to appropriate feeding grounds; c) habitat transformations at other Iberian wintering localities; d) losses of other alternative stopover areas along the migration route; and e) high food availability due to recent mechanization and intensive cultivation procedures (Alonso *et al.* 1983b). The present study has focused on the relationship between seasonal and spatial variations in food supply and crane numbers and distribution.

Study area

Laguna de Gallocanta (40.58 N, 1.30 W, 990 m asl) is a saline lake with a water surface of 1800 ha. It lies in a basin of 53,637 ha, most of which is intensively cultivated farmland, mainly wheat and barley. In the last two years sunflower has been grown in the zone, and, after a poor harvest, large amounts of waste sunflower seeds were left on the ground. A more detailed description of the study area is given in Proyex SA (1981). For the purposes of this investigation, the study area was divided into three sub-areas A, B, and C, each comprising approximately 11,000 ha of farmable land (Fig. 1). In 1981-82 only sub-areas A and B were surveyed.

Methods

Numbers and distribution of the cranes

From late October to late March we visited the area for two days every week. Numbers of cranes leaving and entering the roost were counted and daily survey trips of around 100 km over the whole area, each lasting 8-10 hours, were made. The crane flocks were observed with binoculars and telescope (20-60x) and their locations were plotted on aerial photographs scale 1:18000. For each flock we recorded the number of birds, the percentage of birds actively feeding, and the type of foraging ground.

Food availability

The relevant extent of different cover types was assessed in 1981-82 by means of questionnaires sent to farmers, concerning farming chronology and other crop characteristics. Answers were received from 66 farms covering 190.11 ha. In 1982-83 a 37 km transect was made fortnightly through the study area, and the cover type on each side of the road was recorded. Availability of waste cereal grain on stubble fields was measured by counting the grains in 25 plots of 0.25 m^2, sampled in 5 randomly selected fields. The mean number obtained was 37.4 ± SE 9.98 grains per unit. The mean dry weight of one grain is 0.027 g (n= 900), which gives an average dry weight of 40.4 kg per hectare. The amount of grain in sown fields was obtained from farmers' information. Waste seed availability on sunflower stubble fields could not be measured directly, but estimations were made assuming that the cranes' relative utilizations of this cover type and of cereal fields were proportional to the amounts of food on each of them.

Results

Crane numbers and food availability

The area corresponds to Melvin and Temple's (1982) definition of a traditional stopover area. Nevertheless, a variable number of birds remain in the area between the postnuptial and the prenuptial staging periods (Fig. 2). Over the last few years an increase in the peak numbers of birds stopping at Gallocanta in autumn, as well as a lengthening of the corresponding occupation periods has been observed (Alonso *et al.*

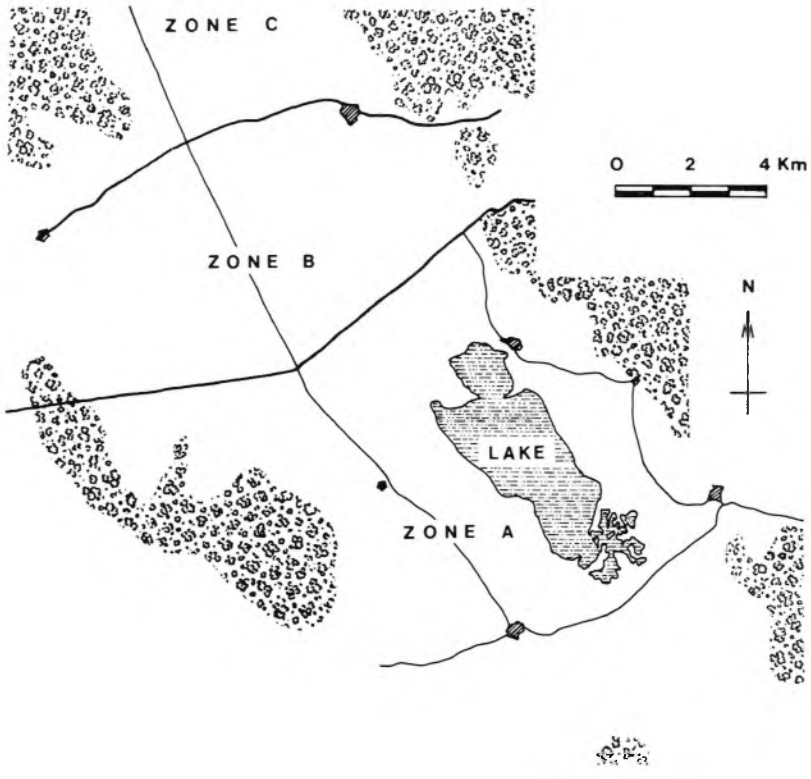

Figure 1. Sketch map of the study area showing the lake, *Quercus*- wood areas and the main roads dividing the area in three zones A, B and C (see text).

1983a,b). Numbers of cranes using the area in spring have been smaller and lengths of stay briefer than in autumn in both years, expecially in 1982-83.

Cranes use both harvested and sown fields as feeding grounds (see below). The seasonal variation of food availability also shows two peaks: the first appears as a consequence of the large number of stubble fields in autumn and the second is determined by an increase of the sown surface in spring (Fig. 2).

Two important weather features strongly influenced the farming cycle and the crane numbers. First, the absence of rainfall during the 1982-83 winter delayed sowing until March. Second, a long frost during January 1983 impeded the cranes from digging up grain from the frozen ground and was probably the cause of the smaller numbers of birds overwintering in the study area that year.

Feeding habits

Monthly variation in crane preferences for the various cover types considered is shown in Tables 1 and 2. Cranes forage mainly on cereal and sunflower cultivated ground, both stubble and sown fields, other minor crops being apparently not used. Untilled grounds, such as pastures, lake and road edges, and other natural grasslands, were grouped as "others". Crane utilization figures of sunflower stubble fields in November and December were much higher than the relative extent of this cover type in both years (Tables 1 and 2). This indicates the sunflower stubble fields were strongly selected as feeding areas during those months (Fig. 3). Cereal stubble fields were also intensively used in autumn and early winter in 1981-82, with peak usage in December, although preference for this cover type was higher in January and Feb-

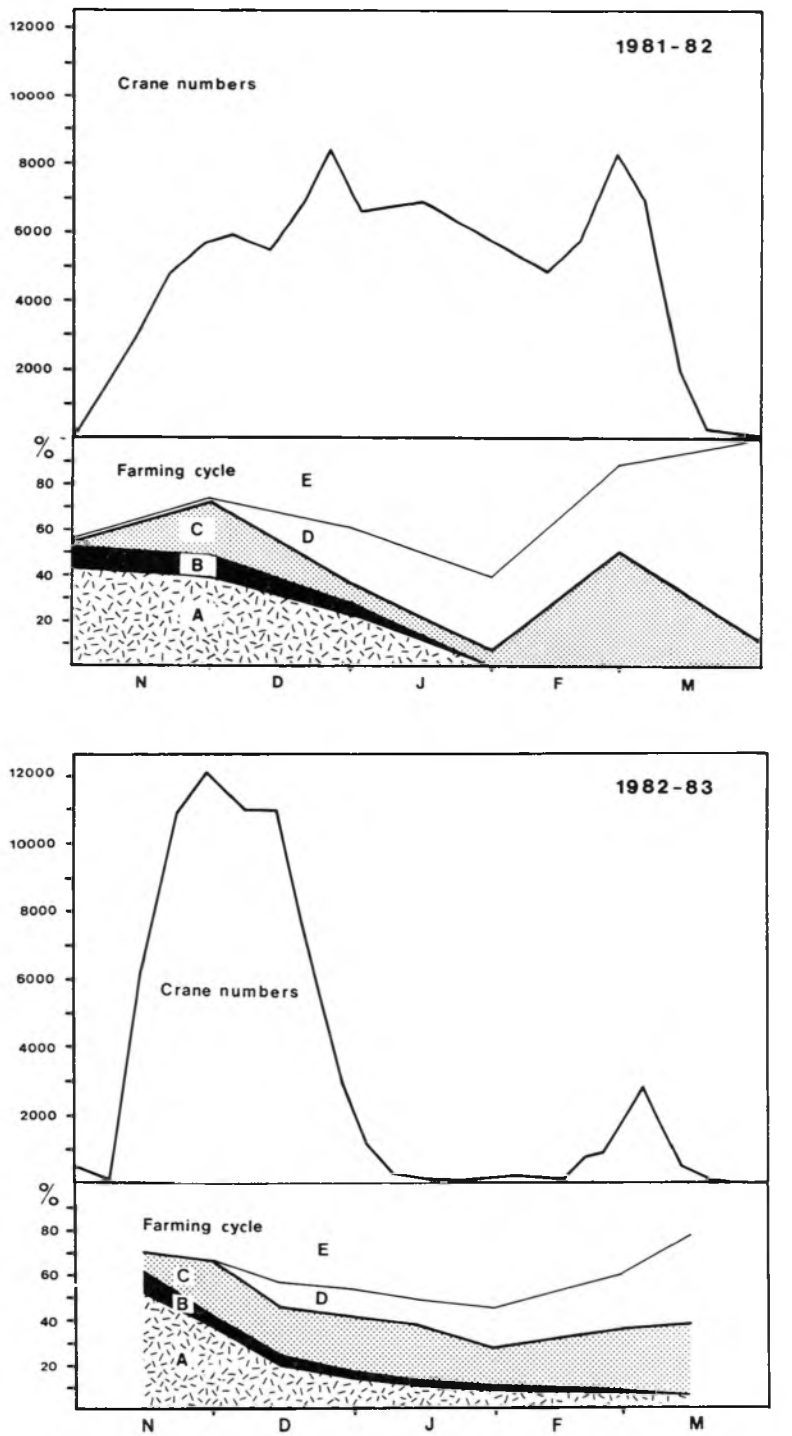

Figure 2. Seasonal variation of crane numbers and relative extent of the different cover types considered in the cultivated area, in 1981-82 and 1982-83.
A = cereal stubble fields; B = sunflower stubble fields; C = recently sown grounds. Unshaded areas are not utilizable as feeding grounds.

Table 1. Relevant extent of the different cover types (a) and percentage of birds observed feeding on each of them (b) in 1981-82.

		NOV	DEC	JAN	FEB	MAR
Sunflower stubble fields	a)	2.38	1.90	1.27	0.79	0.16
	b)	58.69	13.31	0	0	0
Cereal stubble fields	a)	45.33	26.69	+	+	0
	b)	17.42	55.74	23.07	12.73	0
Recently sown fields	a)	21.46	7.12	6.54	47.25	10.51
	b)	21.85	21.81	62.25	78.79	91.01
Ploughed and sprouted cereal fields	a)	26.22	59.65	87.52	47.27	84.62
	b)	0	0	0	0	0
Others	a)	4.60	4.63	4.66	4.68	4.71
	b)	2.04	9.14	14.68	8.48	8.99
Total no. of birds observed feeding		8880	24980	19632	21165	8892

Table 2. Relative extent of the different cover types (a) and percentage of birds observed feeding on each of them (b) in 1982-83

		NOV		DEC		JAN	FEB	MAR
		1–15	16–30	1–15	16–31			
Sunflower stubble fields	a)	10.11	5.69	4.68	3.67	3.06	1.37	0.12
	b)	21.37	65.71	1.94	1.30	0	0	0
Cereal stubble fields	a)	48.63	35.10	17.94	12.19	8.06	5.72	4.48
	b)	60.91	15.55	14.53	31.04	1.05	0	0
Recently sown fields	a)	8.54	22.74	20.08	22.84	18.48	26.00	31.02
	b)	0	16.16	80.75	54.47	79.78	41.03	93.27
Sprouted cereal fields	a)	0.27	0	10.31	10.55	12.03	22.82	33.19
	b)	0	0	0	0.32	0	0	0
Ploughed fields	a)	24.38	29.75	39.53	43.92	51.00	34.97	23.80
	b)	5.66	1.52	0.04	3.33	2.01	0.09	0
Others	a)	2.79	3.32	4.10	4.51	4.81	6.02	4.18
	b)	12.05	0.18	4.10	9.35	8.56	58.88	6.79
Total no. of birds observed feeding		5863	22741	17098	5719	994	2805	6346

ruary. In 1982-83, utilization of cereal stubble fields decreased markedly in late November, owing both to high food availability on sunflower stubble fields after a poor harvest and to diminished food supply as a consequence of the sprouting of much of the waste grain on cereal stubble fields. The poorer nutritional quality of the cereal stubble that year greatly reduced the use by the cranes of this cover type throughout the whole season. Recently sown grounds were increasingly used throughout the 1981-82 season, while in 1982-83 two utilization peaks occurred, coinciding with the main sowing periods in the study area (Fig. 2 and Table 2). The poorer quality of the cereal stubble fields was probably also the cause of the positive selection of the sown grounds in 1982-83. This is also supported by the significantly higher feeding intensity in sown grounds in 1982-83 (Table 3). Sprouted cereal and ploughed fields were avoided (Tables 1 and 2). The lower numbers of birds and the reduced feeding intensity in naturally vegetated land suggest that this cover type is positively selected, probably owing to the need to satisfy certain nutritional requirements to complement the

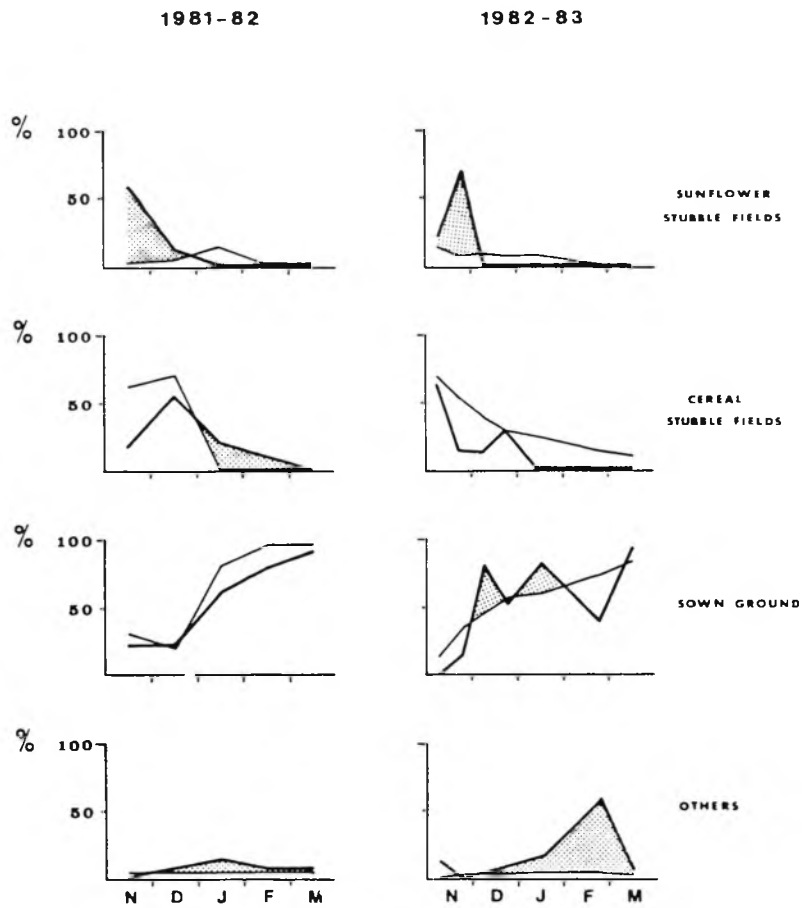

Figure 3. Seasonal variation of relative extent of the different feeding grounds (thin line) and utilization percentage (thick line). Shaded area represents positive selection.

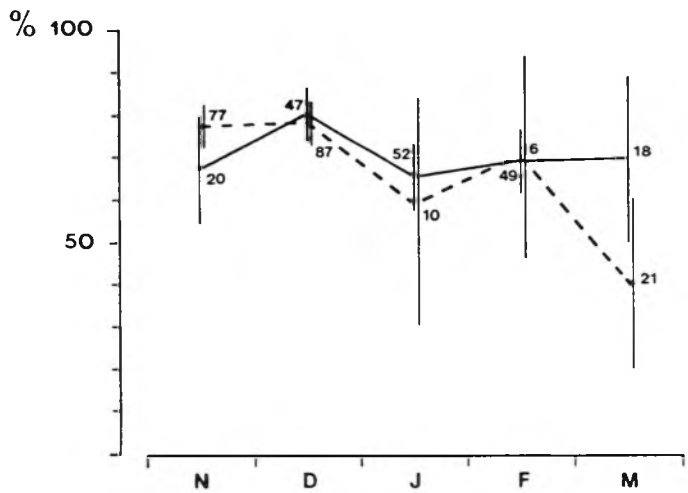

Figure 4. Monthly variation of the feeding intensity in 1981-82 (solid line) and 1982-83 (dashed line). The vertical lines represent 95% confidence intervals. The figures are numbers of flocks.

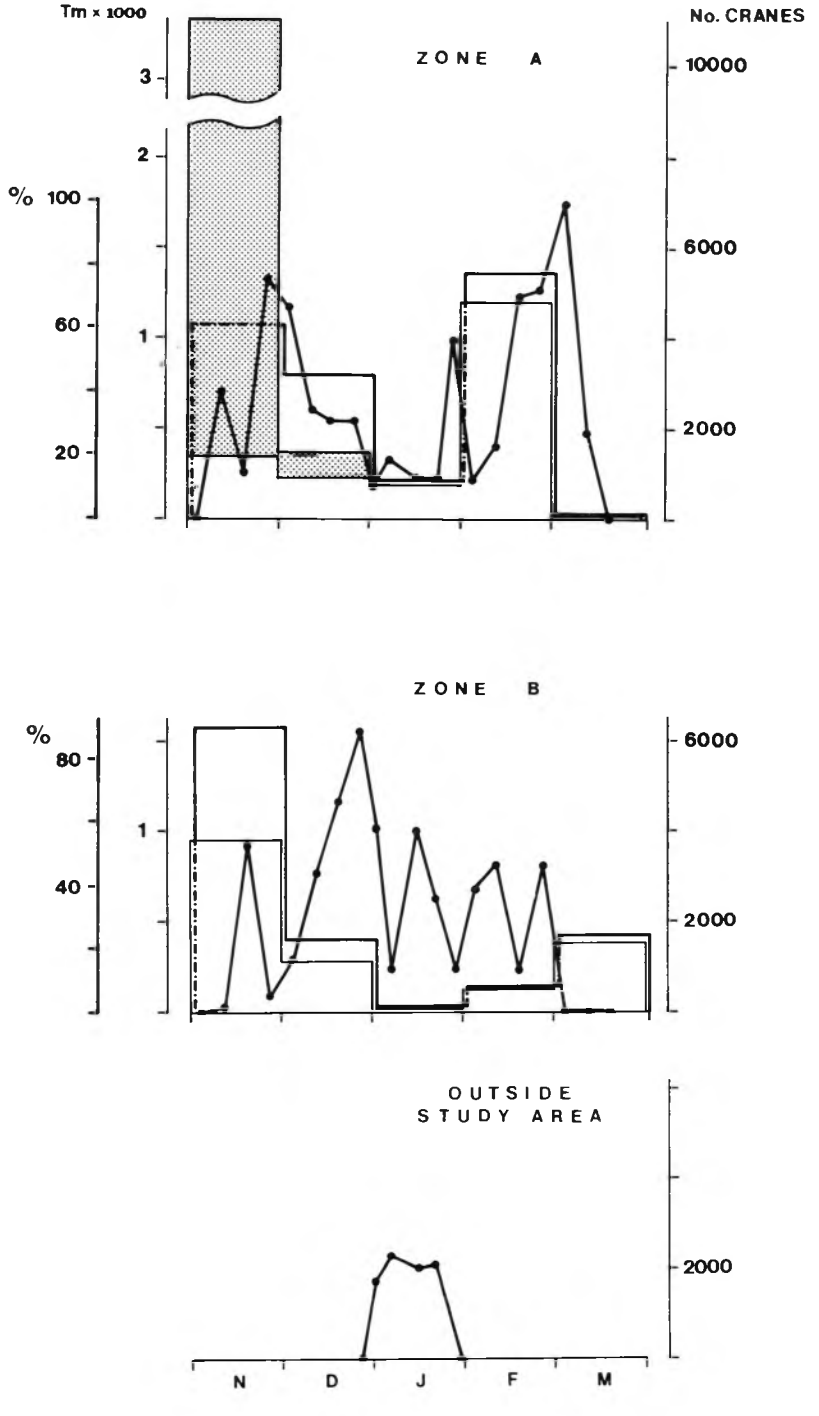

Figure 5. Seasonal variation of crane numbers (solid line) in relation to total food availability (thin line histogram) and to relative extent of utilizable surface (thick line histogram), for 1981-82 (left side) and 1982-83 (right side). Shaded bars represent estimated waste seed weight on sunflower stubble fields. Crane numbers in a zone adjacent to the study area are also included.

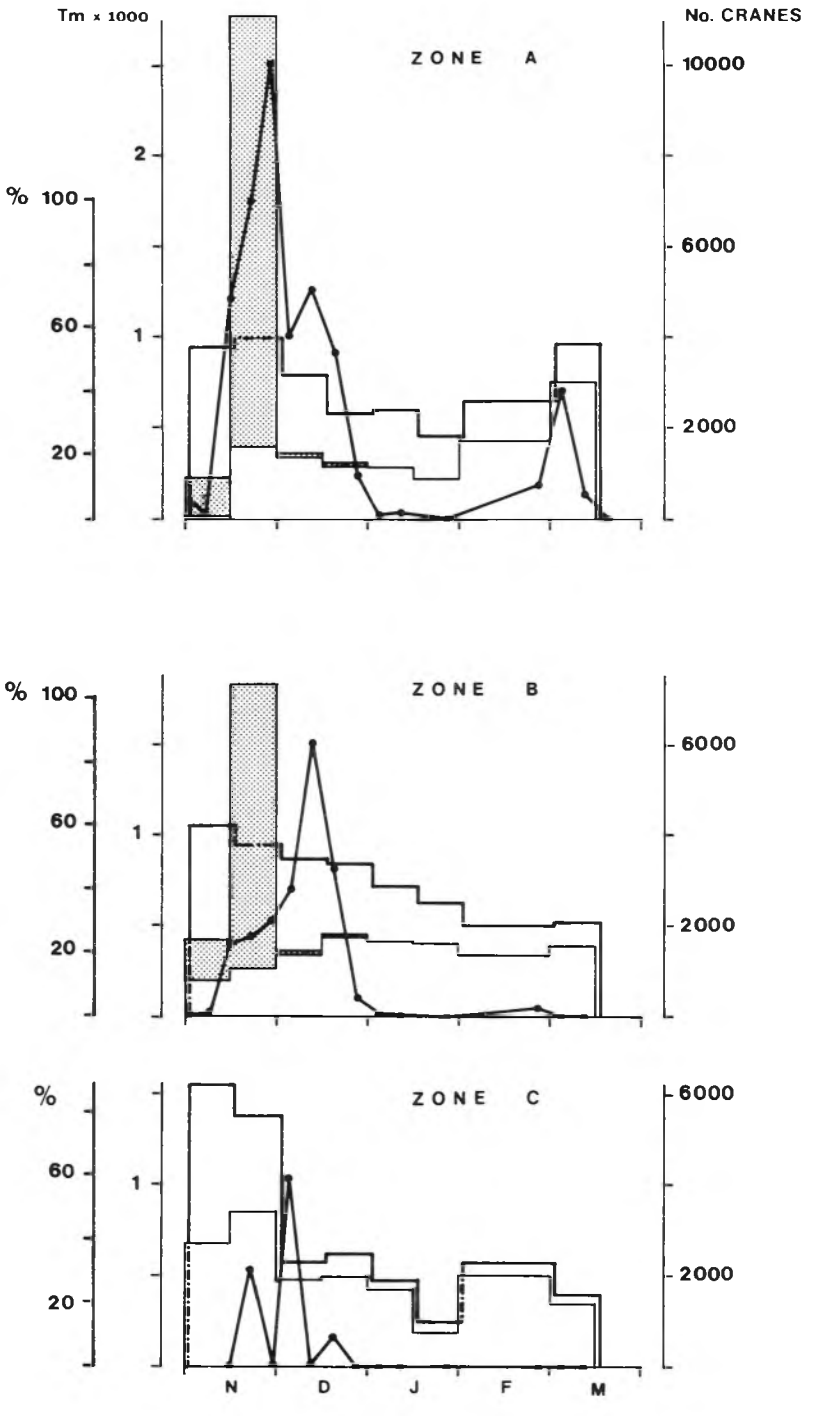

Figure 5. (continued)

basic cereal grain diet (Krapu 1979; Reinecke & Krapu 1979; USFWS 1981).

Differences between years in the seasonal pattern of feeding intensity were only significant during the spring migratory period – February and March – ($t = 2.50$; $p < 0.05$) (Fig. 4).

Distribution of the cranes

The correspondence between food supply abundance and bird numbers appears to be closer in zone A, which is nearer to the roost, than in the more distant zones B and C (Fig. 5). While peak numbers of cranes in zone A coincide with the highest food supply and feeding ground availability, highest use of zones B and C occurs with a certain delay in relation to maximal food resources they contain. Peak crane concentrations in autumn were found mainly on sunflower stubble fields, which were more abundant in zone A. The birds were especially attracted by a large extension of sunflower stubble adjacent to the roost in both years (Fig. 6, November). The series of ups and downs in the occupation model in 1981-82 (Fig. 5) shows that cranes often changed feeding sites during mid-winter. Simultaneously, the birds utilized another very distant feeding zone outside the surveyed area (Figs. 5 and 6, January and February). This long distance feeding was also observed in the following year, with many fewer cranes. In spring cranes preferred to feed close to roosts, zone A, where food abundance figures were the highest in both years.

Dispersion and flock size

The monthly variation in the mean dispersion of feeding flocks is statistically significant in both years ($F_{0.01; 4; 555} < 14.74$ in 1981-82 and $F_{0.01; 4; 477} < 15.35$ in 1982-83). Dispersion figures increased from November until January and then decreased to minimum values in March (Fig. 7).

Variation between flock sizes for the different months was statistically significant only in 1981-82 ($F_{0.01; 4; 574} < 3.48$), although the seasonal trends were clearly identical in both years (Fig. 7). Monthly dispersion and flock size figures were inversely correlated ($r_S = -0.769$; $p<0.01$). There were significant differences between years between mean dispersion figures in November ($p<0.05$), December ($p<0.05$), February ($p<0.01$) and March ($p<0.01$), but monthly mean flock sizes were statistically identical in both years.

Discussion

Over the last 20-30 years important changes in the migration and wintering patterns of Cranes in Iberia have been noted (Bernis

Table 3. Feeding activity in the different cover types, expressed as percentage of birds actively feeding in foraging flocks.

	Sunflower stubble fields	Cereal stubble fields	Recently sown fields	Others
1981-82				
x	83.47^{a}	76.49^{b}	$74.34^{c,d}$	$21.47^{a,b,c}$
σ_{n-1}	5.31	23.20	22.20	29.46
n	7	74	99	10
1982-83				
x	$78.35^{a'}$	$73.64^{b',e}$	$83.31^{c',d,e}$	$27.59^{a',b',c'}$
σ_{n-1}	17.24	25.13	21.88	34.05
n	17	75	74	25

Significance levels (t – Student test):

aa, bb, cc, a'a', b'b', c'c'; $p<0.001$
dd; $p<0.01$
ee; $p<0.05$

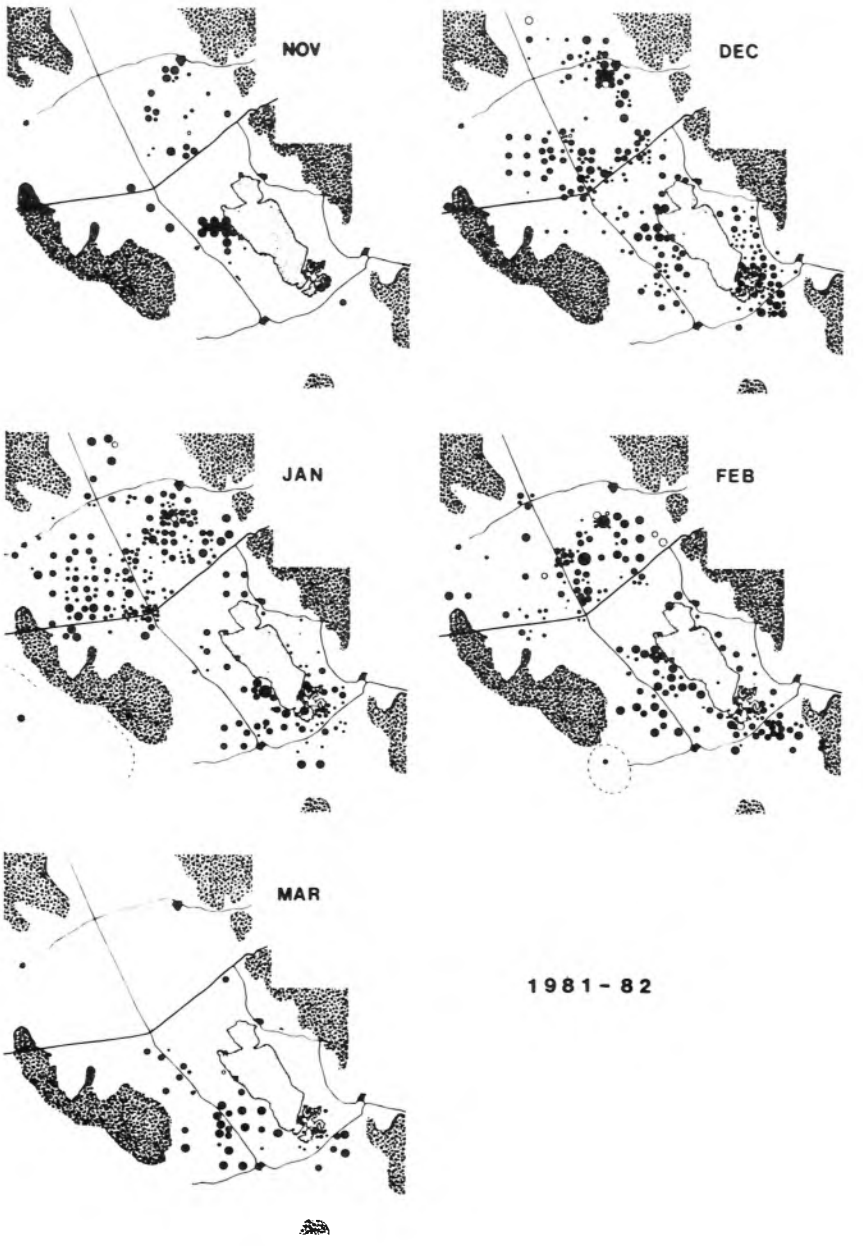

Figure 6. Distribution of feeding (black dots) and drinking (open dots) flocks on foraging areas in 1981-82 as an example of the seasonal variation pattern of the cranes' dispersion in the study area.
• 1–10 birds; • 11–50 birds; ● 51–250 birds; ● 251–1250 birds; ● more than 1250 birds. Flocks foraging outside the study area were represented by an asterisk (January and February, see also Fig. 4).

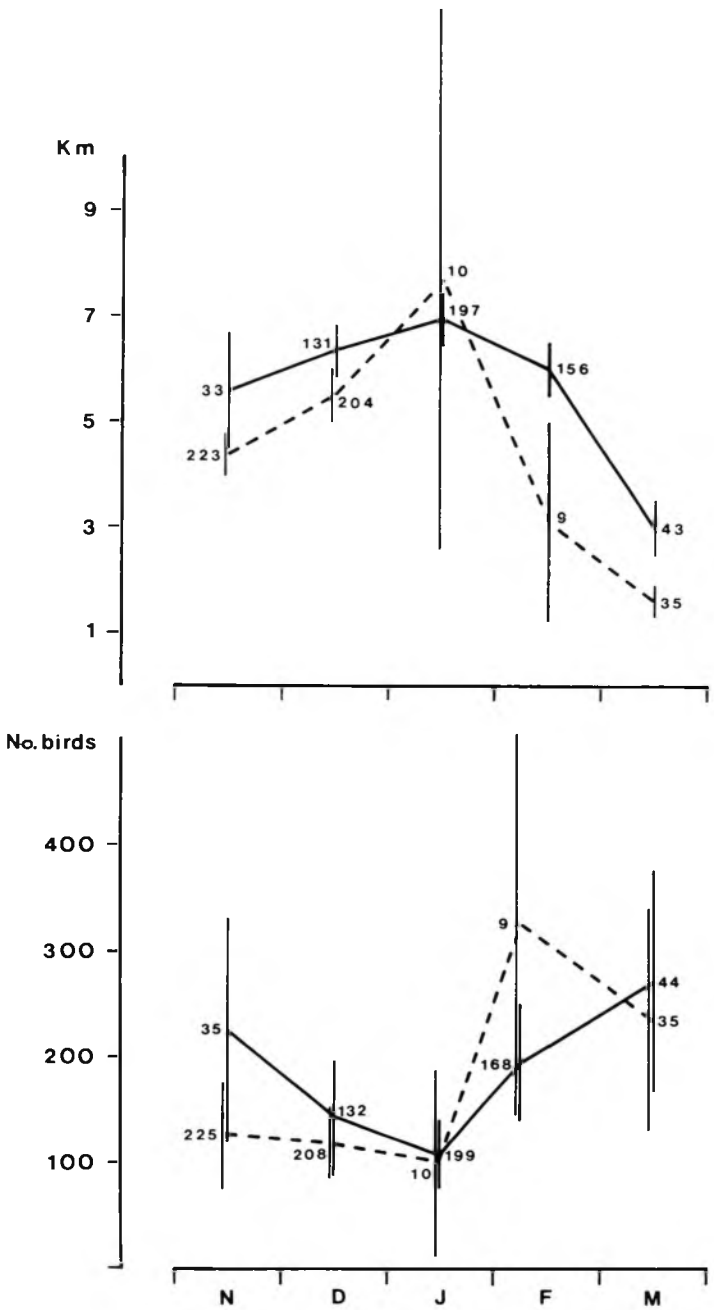

Figure 7. Monthly variation of average distance from the feeding flocks to the nearest roost (upper figure) and of mean flock size (lower figure) for 1981-82 (solid line) and 1982-83 (dashed line). Vertical lines represent 95% confidence intervals. The figures are numbers of flocks.

1960; Alonso *et at.* 1983b). Cranes have been increasingly using the Laguna de Gallocanta as a stopover area, benefiting from abundant food supplies in harvested and sown fields. The potential importance of traditional stopover areas in allowing birds to accumulate energy reserves needed for migration and reproduction has been stated for the Sandhill Crane *Grus canadensis* (Lewis 1979a,b; Reinecke & Krapu 1979; Iverson 1981) as well as for many other avian species before and during migration (Kear 1963; Berthold 1975; Owen 1976; Reed 1976; Thomas 1981). The coincidence of the two periods of highest food availability with both migratory peaks of the Crane is of fundamental importance in determining the staging model in our study area. Surely two stops, in spring and autumn, would not occur if food supplies were abundant only during one of those phases, as at various traditional stopover areas in North America (Buller 1967; Stephen 1967; Johnson 1976; USFWS 1981). However, the occupation model, numbers of birds stopping and length of time spent at Gallocanta, varies within and between years according probably to feeding conditions, which are mainly determined by the farming cycle and the weather.

The occupation model described above may be influenced by two important sources of variation in food availability. The first depends on local farming practices: the rapid increase in the relative sunflower-stubble surface area from 0% in 1980 to 15% in 1982 appears to be one of the main causes for the higher numbers of birds and for the longer staging periods noted in autumn as compared to previous years (Alonso *et al.* 1983b, and present study). In fact, sunflower stubble fields are the most strongly selected feeding grounds, owing surely to the higher density of waste grain and to the nutritional quality of this resource. The depletion of food in this cover type causes a decrease in the numbers of birds using it in mid-winter. Continued tillage of the more abundant cereal farms prevents a similar depletion of cereal grain but determines a shift in the cranes' preference from cereal stubble fields in autumn to sown fields in spring.

Weather is the second cause of variation in food supply abundance: rainfall occurring at the appropriate time in autumn may cause the waste cereal grain to sprout, with a subsequent reduction in the amount of food available. A long frost may also cause an important decrease in food availability by preventing the cranes from digging up the cereal seeds from the hard frozen ground.

Cranes only consumed approximately 5% of the total available cereal grain in January, when food supplies were scarcest (Alonso *et al.* 1983c). However, distributional opportunism and highest dispersion of feeding flocks indicate a greater searching effort and suggest that the population size could be close to the carrying capacity of the zone at that time.

Numbers of cranes using the area in spring have been more variable, depending mainly perhaps on the physiological-nutritional condition of the birds. There is no clear correspondence between crane numbers and food availability figures in spring in either year. The small numbers of birds stopping at Gallocanta in spring 1983 and their lower feeding intensity suggest that, perhaps this year, cranes had accumulated enough reserves at the wintering locations in SW Spain, making the spring staging at Gallocanta unnecessary.

Agricultural environments are characterized by localized food resources unevenly distributed in time and space. Thus, species capable of exploiting them should have an appropriate social structure and efficient information exchange mechanisms (Schoener 1971; Ward & Zahavi 1977; Wiens 1976; Wiens & Johnston 1977). Our results indicate that only when food availability decreases in the feeding areas adjacent to the roost, do birds intensify the utilization of more distant sites, in accordance with Hamilton & Gilbert's (1969) findings, namely the existence of a balance between the costs and benefits associated with flying various distances from the roost. The mechanism by which efficient exploitation of the whole area is attained probably operates as follows: during the cranes' arrival phase in autumn most birds forage close to the roost, while a variable number of birds, mainly adults without offspring and subadults (Alonso *et al.* 1983b), explore more distant sites. When food supplies decrease near the lake, these birds lead the rest of the population to other areas with more abundant food resources. If an adequate number of birds remains there long enough, a similar set routine is established in spring. Supporting this hypothetical model, the mean flock dispersion increases as food supply decreases. The existence of significant

within and between year differences in the monthly mean dispersion figures reflects adaptability to changeable environmental conditions. The absence of marked differences in flock size between years suggests that other factors, probably social in nature, may interact with physical ones in determining variations in gregariousness.

Acknowledgements

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Summary

The numbers, distribution and feeding habits of Cranes *Grus grus* were studied in relation to food availability in a cereal-growing farmland at Laguna de Gallocanta, Spain, from October 1981 to March 1983. The seasonal variation patterns of bird numbers and food availability are similar, both showing peaks in autumn and spring and a minumum in January. The correspondence is higher in zones adjacent to the roost, suggesting that birds prefer to forage as close to the roost as possible. Poor feeding conditions in mid-winter determine a decrease in the mean flock size and a higher dispersion of the birds, as well as a reduction in the wintering population size. Cranes utilize cultivated ground and natural grasslands as feeding areas. Sunflower stubble fields are strongly selected in autumn, while cereal stubble and sown fields are mainly utilized in autumn and spring respectively. Natural grasslands are positively selected.

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