Ornis Fennica 69:19–28. 1992

Use of marshlands by Common Cranes in winter in south-western France

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with the collaboration of the F. D. C. Landes Technical Service

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Received 21 August 1990, accepted 23 September 1991

The number of Common Cranes (*Grus grus*) wintering in the main wintering grounds in SW France increased from 25 in 1977 (first observation year) to 2500 in 1988. The annual variation observed around this general tendency can mainly be explained by autumn rainfall, which causes early flooding of the marshland used by the cranes. The night roosts are located in water basins and low heaths. During the day, the cranes prefer the low heaths, where they feed intensively. Five micro-habitats, defining an after-fire succession, are described in the low heaths. The regrowth of the vegetation after fires caused by military activities is rapid and the cranes seek out zones undergoing recolonization. The management of the heaths by fire seems to favour the cranes.

1. Introduction

The Western European population of the Common Crane (*Grus grus)* traditionally winters in the SW of the Iberian peninsula and, to a lesser extent, in Morocco (Bernis 1960, Géroudet 1978, Cramp et al. 1980, Fernandez-Cruz 1981, Fernandez-Cruz et al. 1987). However, for the past ten years, several hundred or thousand individuals have wintered in France (Boutet & Petit 1985, Petit 1986, Riols 1987). This new situation seems to be due to the destruction of wintering habitats in Spain (Alonso et al. 1983), to the extension of certain types of crops, such as maize, used as feeding grounds (Petit 1986, Génard 1987, Riols 1987), and to the permanent occurrence of wetlands, used both as night roosts and as complementary feeding areas (Génard 1985, Petit 1986, Génard 1987). The maintenance or extension of these wintering grounds calls for a thor-

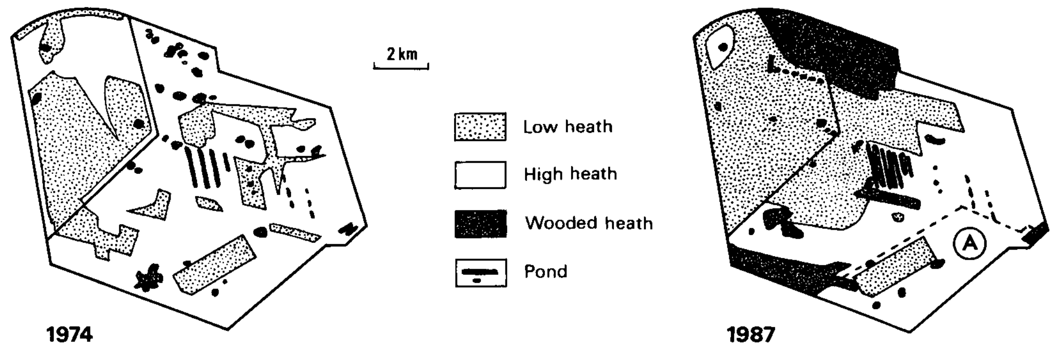

Fig.1. The study area in 1974 and 1987. A (border shown with broken line) was permanently accessible to researchers; other parts (80%) were occasionally accessible.

ough consideration of the way these environments should be managed, requiring a more precise knowledge of the needs and activities of wintering cranes.

Research carried out on the wintering grounds of the Common Crane has thus far focused on the birds' activities in farmland in relation to their specific characteristics (food supplies, sources of disturbance, distance from sleeping quarters, etc.; Alonso et al. 1984, 1986, 1987, Génard 1985, 1987, Génard & Bereyziat 1988, Petit 1986). Few studies have dealt with the occupation of wetlands located near farmland (Hernandez Fernandez 1984). This study was, therefore, made on a large marshland in SW France, which is a wetland of international importance for the Common Crane and its main wintering zone in France. The other marshlands in SW France are too small or suffer too much from disturbance to be intensively used by cranes.

Our objective was to describe the variation in the number of wintering Common Cranes and to relate this variation to environmental conditions. Although generally increasing, the number of cranes fluctuates enormously from year to year (Petit 1986). Thus, we focused on describing the increasing trend and on clarifying the mechanism of the yearly variation. As the number of cranes also varies in space, we attempted to characterize the habitats used by cranes wintering in marshy heaths. We defined the main types of environments selected, described the characteristics of the microhabitats that these contained and defined the microhabitats used.

2. Study area

The study site, located in SW France (44°12′ N; 0°23′ W) at an average altitude of 120 m, has an oceanic climate. It forms a 100 km^2 plot of marshy heaths within a zone dominated by pine forest (*Pinus pinaster*) and maize fields (Fig. 1). The proportions of forest and farmland in the wintering grounds are 88% and 12% respectively. The heath is part of the Poteau military camp and is almost completely flat. Rainfall causes a rapid rise in the water table, which can reach the soil level. A high *Erica scoparia* heath (0.5 to 2 m) is partly forested by *P. pinaster*. Low *Molinia caerulea*-dominated heaths are regularly subject to fires. The ponds are shallow. The proportion of wooded land and of low heaths increased from 1974 to 1987 (Fig. 1). The drainage operations carried out on the site in the past few years limit winter flooding, but the permanent water surface has increased due to recent installations. Fires lighted intentionally for military purposes or accidentally during military excercises regularly rejuvenate the environment. In 1987, 14% of the surface area had recently been burned.

3. Methods

3.1. Interannual fluctuation of the number of cranes

The number of wintering birds was estimated during 11 winters, from 1977/78 (first wintering) to 1983/84 and in 1987/88 by the Regional Ornithological Centre of Aquitaine-Pyrénées (see Petit 1986) and by the authors from 1984/85 to 1986/87. Cranes were censused 10 to 15 times each winter. The census was carried out by counting flights from feeding grounds to sleeping quarters located in the Poteau camp in January and February at sunrise or sunset, or by counting birds resting in the fields during the day (Petit 1986). We used the maximum number obtained in the counts.

The variation of crane numbers was divided out into an increasing trend, due to the recent colonisation of the study area, and the yearly variation. As a first step, the increasing trend was fitted with a polynomial function of the "year" variable. As a second step, we removed the effect of increasing crane numbers, and tried to explain the residuals with a stepwise multiple regression on variables describing the annual changes in environmental conditions. We hypothesized that these changes are mainly due to variation in the degree of flooding of the study site. As no direct measurement of this degree was available, we used rainfall as an index of flooding, and the variables used in the regression were: winter rainfall (from December to March, highest water level), spring rainfall (from April to June, declining water level), summer rainfall (from July to September, further decrease of water level to its lowest level), autumn rainfall (from October to November, increasing water level). The plot of residuals versus estimates of models and the Durbin-Watson statistic (d) made it possible to test the autocorrelation of residuals (Tomassone et al. 1983).

3. 2. Crane habitats

Night. First we had discussions with the Poteau camp personnel in 1985–1988, who located the sleeping quarters during night outings, at dawn or at twilight. Then, we added to these data those of Petit (1986) and those from 23 observation days spent from 1986 to 1988 in the observatories situated inside or just outside the camp.

Day. Crane sightings were made by the camp personnel during surveillance rounds carried out throughout the entire study zone in 1986–88. Each observation was entered on a map. The time, number of cranes and the habitats (low heath, high heath, forested heath, burned zone, water basin) were noted.

We compared the distribution of individual birds (n = 6020) and of bird group (n = 52) sightings among the different types of habitat, to that of 100 sample points randomly spread out through the whole camp, which were described in January 1987. The distribution of crane groups was compared to this random distribution using the Marcum & Loofsgaarden (1980) technique, i.e. with a goodness-of-fit test followed by contrast tests with a risk of $P = 0.05$ if the null hypothesis (all habitats are neutral) was rejected (see Scherrer 1984). The test procedure was applied only to crane groups, because it demands observational independence (Alldredge & Ratti 1986), which is not the case for individuals in the same group. When possible, the proportion of birds feeding was noted to find whether the marshlands studied could act as a feeding zone that complemented the corn fields.

In order to define the microhabitats used by cranes, we described the vegetation and the crane presence in a 300 ha rectangular plot of low heath. The vegetation was described in February 1987 using 109 sampling points distributed at 200 m intervals along transects separated by 250 m. At each point, the percentage covers were estimated within 25 m around the observer for the main vegetation types (willow *Salix atrocinerea*; heaths > 10 cm of *Erica scoparia*, *Erica tetralix;* heaths < 10 cm of *Erica ciliaris*, *Calluna vulgaris;* gorse *Ulex nanus;* ferns *Pteridium aquilinum;* Graminaceae > 10 cm (*Molinia coerulea*); Graminaceae < 10 cm (*Agrostis setacea*); cinquefoil *Potentilla tormentilla*; mosses), the bare ground and the burned areas, using the scale 1%, 5%, 10%, 20%, ..., 90%. Two-thirds of the 300 ha unit was again described in February 1988, using 49 sampling

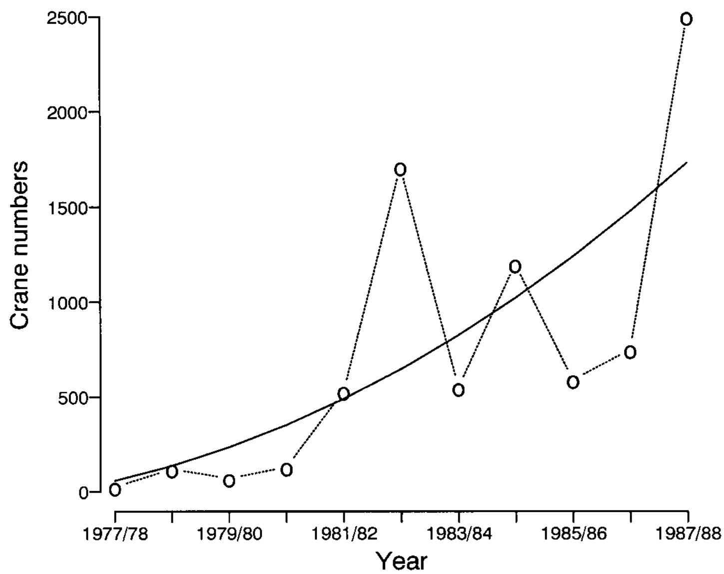

Fig. 2. Crane numbers in the different years. The fitted polynomial function (C. n. = 48.3 Year + 9.9 Year^2) is drawn.

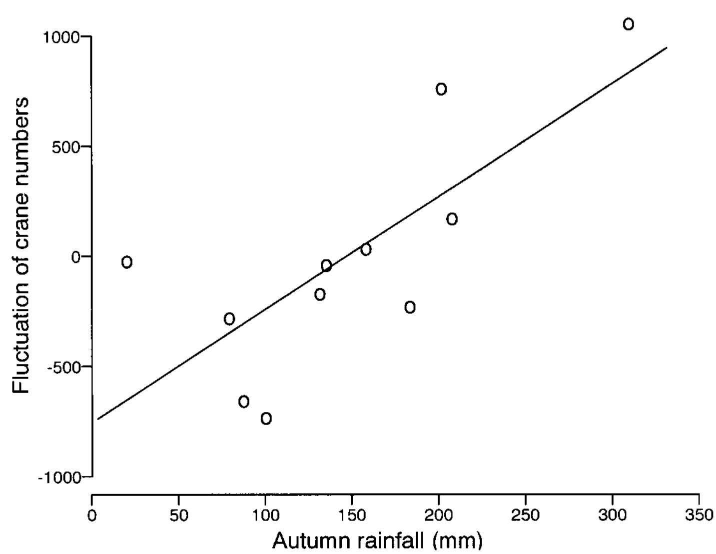

Fig 3. Fluctuation of crane numbers around the fitted polynomial function (see Fig. 2) in relation to autumn rainfall. The linear relationship (C. n. fluctuation = 5.1. Autumn Rainfall –759) is drawn.

points, to assess changes in habitat composition. As the uniform landscape and the sensitivity of cranes to observers made it difficult to describe the spatial distribution of the birds by direct observation, we took into account the presence of signs left by the cranes: feathers, droppings, etc. Tracks were not considered, as they require bare soil. In January 1987, February 1987 and February 1988, the 300 ha unit was sampled over a distance of 12500 m, using transects separated by 250 m. The observer closely examined the soil on both sides of the line to a width of 1 m. A total of 37500 m of transects studied made it possible to discover 85 sites with signs of cranes. The vegetation was described for each site.

In order to define the microhabitats present in the unit, the matrix of 109 sampling points (rows) described by the 11 habitat variables (columns) was reduced by correspondence analysis (Greenacre 1989) for elimination of random variation and orthogonalization of variables (Converse & Morzuch 1981, Bouchet 1985), and then examined by clustering the points described by the highest ranking components, using Ward's minimum variance method, which is particularly suited for use after correspondence analysis (Roux 1985). The microhabitat variables characterizing each class were detected by an analysis of variance followed by multiple comparison tests (Tukey-Kramer) if a significant difference between classes was noted (Sokal & Rohlf 1981).

We calculated the coordinates (F_i) of the 49 points described in 1988 and of the 85 sites with signs of crane presence on the factors of the correspondence analysis: $F_i = A_j * X_{ij}$ (Benzecri 1973) with $X_{ij} = j^{th}$ microhabitat variable value for the i^{th} record and A_j the eigenvector value for the j^{th} variable. Each of those 49 and 85 sites was assigned to a microhabitat on the basis of these coordinates. For that purpose, we first performed a discriminant analysis on the microhabitat classes described by the factors of the correspondence analysis, and then used the discriminant functions to class the sites among microhabitats. The quality of the discriminant analysis was verified by calculating the pseudo F of the discriminant axes and the percentage of point regrouping (Foucart 1985, Tomassonne et al. 1988). To define the microhabitat selected by the cranes, we compared the distribution of sampling points with that of the crane presence signs amongst the microhabitats, using a goodness-of-fit test, followed by contrast tests (see above paragraphs).

4. Results

4.1. Interannual fluctuation of the wintering population

From 1977 to 1988, the size of the wintering crane population rose from 25 to 2500 birds. This increase was modelled by a 2nd degree polynomial function ($n = 11$, $r = 0.88$, $P = 0.001$) between the number of birds and the numerical order of the year (Fig. 2). Using this function, we could calculate the relative growth rate ($l/N*dN/dt$) of the population, which decreased from 65% per year in 1978 to 15% per year in 1987. Spring, summer and winter rainfall did not affect the fluctuation around the general increasing trend (respectively $r = -0.007$, 0.048 and -0.099). Autumn rainfall was well correlated with this fluctuation ($n = 11$, $r = 0.75$, $P = 0.008$), being the only rainfall variable selected by the stepwise multiple regression (Fig. 3). The residuals were not related to the estimates of the two models. Moreover, the values of the Durbin-Watson statistic ($d = 2.1$ and 1.8) allowed rejection of the hypothesis of an autocorrelation of residuals. Thus, the models were considered to be reliable. The "year" variable explained the general increase in population size, while the "autumn rainfall" variable explained the fluctuations observed around this tendency.

4.2. Crane habitats

The zones where cranes were noted at night covered 85% of the water basins, 41% of the low heaths and 1% of the high heaths, but were absent from wooded heaths. The low heaths used are often flooded in winter. The less heaths were flooded, the less they seemed to be used by cranes. During the day, water basins were not sought out. Burned zones were neutral and high or wooded heaths were avoided. Only low heaths were preferred (Fig. 4). Of the crane groups observed in low heaths, 65% included feeding birds. An average of 45% ± 15% ($n = 45$, $P = 0.05$) of the birds in each group were feeding (no significant difference was found between the groups observed in low heaths and those observed in burned zones ($P > 0.05$)).

Five microhabitats were characterized. Their distribution within the low heath studied displays a mosaic pattern. Their characteristics are presented in Table 1. The succession of classes 1 to 5 reconstitutes fairly well an after-fire recolonization gradient. The first stages (1 and 2) are distinguished from the others by even distribution of the main plants, burned zones and bare ground, and thus by a high horizontal diversity, while the last successional stages (4 and 5) are marked by a plant cover close to 100%, the importance of an upper layer (grasses, heath and gorse) and a lower horizontal diversity. The change of habitat composition during the study period was noticeable, since the surfaces of classes 1, 2 and 4 decreased, while that of class 5, where *Molinia coerulea* was dominant, increased (Table 2). The spatial distribution of signs of cranes changed during the study period, but

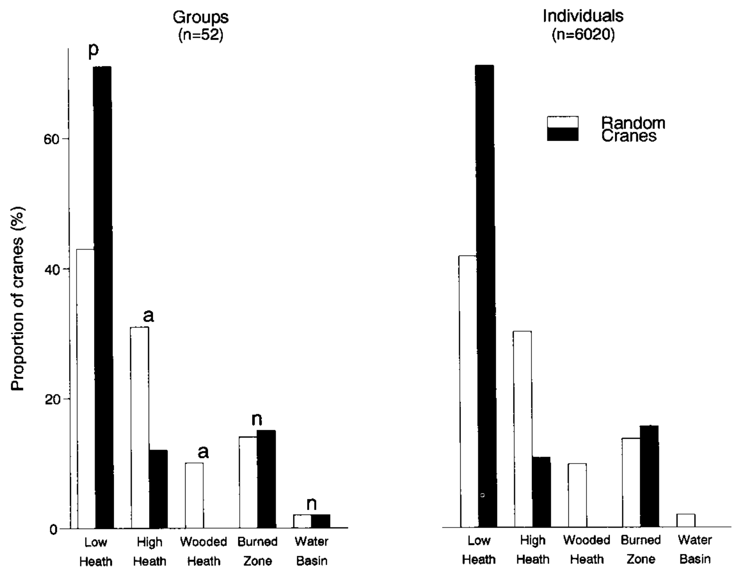

Fig. 4. Crane preference of different habitats in the Poteau military camp (period from 1986 to 1988). Superscripts indicate preference (a = avoided, n = neutral, p = preferred). The goodness-of-fit test was not performed for individuals because of dependence of data.

Table 1. Average percentage of plant and ground cover in five microhabitats identified in the low heath of the Poteau military camp. Mean values followed by different letter superscripts are significantly different ($p < 0.05$). The horizontal diversity was calculated using the Shannon diversity formula Σ_i p_i*Log p_i with p_i = percentage of the i^{th} plant or ground cover element.

	Microhabitat				
	1	2	3	4	5
Burned	20.0^{b}	0.0^{a}	1.4^{a}	0.9^{a}	0.4^{a}
Bare ground	0.0^{a}	27.0^{b}	1.7^{a}	0.9^{a}	0.8^{a}
Moss	11.9^{ab}	8.8^{ab}	20.3^{c}	16.2^{bc}	6.5^{a}
Total low elements	31.9^{c}	35.8^{c}	23.4^{b}	18.0^{b}	7.7^{a}
Grasses < 10 cm	7.9^{b}	7.6^{b}	6.9^{b}	1.2^{a}	4.2^{ab}
Heath < 10 cm	21.6^{b}	17.9^{b}	22.1^{b}	8.2^{a}	5.4^{a}
Cinquefoil	0.6^{a}	2.6^{a}	0.5^{a}	1.2^{a}	0.0^{a}
Total medium elements	30.1^{b}	28.1^{b}	29.5^{b}	10.6^{a}	9.6^{a}
Grasses > 10 cm	26.9^{ab}	22.0^{a}	36.4^{cd}	32.6^{bc}	66.6^{e}
Heath > 10 cm	7.1^{a}	9.1^{a}	7.7^{a}	32.9^{b}	9.6^{a}
Gorse	2.7^{ab}	1.2^{a}	3.9^{bc}	4.7^{bc}	6.1^{c}
Willow	0.1^{a}	3.2^{b}	0.0^{a}	0.3^{a}	0.0^{a}
Ferns	1.2^{a}	0.6^{a}	0.1^{a}	0.9^{a}	0.4^{a}
Total high elements	38.0^{a}	36.1^{a}	48.1^{b}	71.4^{c}	82.7^{c}
Plant cover	80.0^{a}	73.0^{a}	96.9^{b}	98.2^{b}	98.8^{b}
Horizontal diversity	2.3	1.9	1.7	1.6	1.2

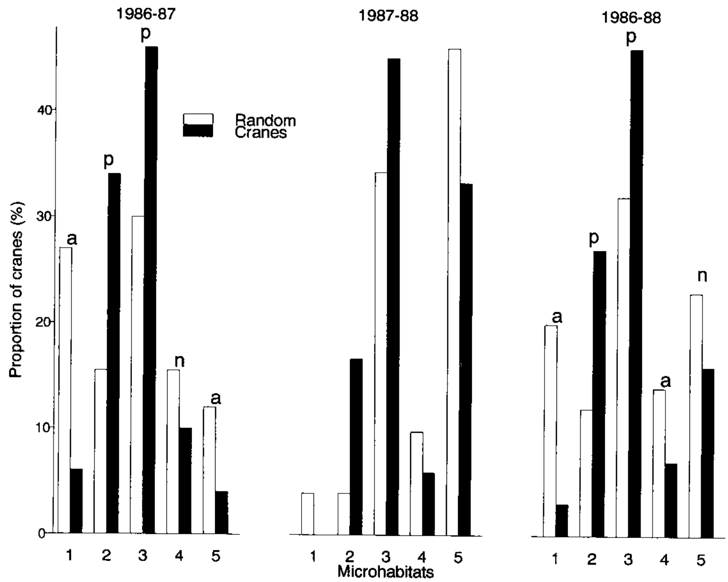

Fig. 5. Crane preference of different microhabitats according to signs of presence in a low heath in the Poteau military camp (see Table 1 for characterization of stages). The 1987/88 sample was too small for testing. Superscripts as in Fig. 4.

their distribution amongst the microhabitats changed only slightly between 1986/87 and 1987/88, so that these two years could be added together for statistical analysis (Fig. 5). The recently burned zones (microhabitat 1) were avoided, whereas those where the ground was partly bare (2) or recolonized by moss (3) were preferred. The zones marked by the importance of an upper layer (4 and 5) were neutral or avoided.

Table 2. Evolution of the different microhabitats (%) in the low heath of the Poteau military camp between 1986–87 and 1987–88. The global difference between the two distributions is significant (χ^2). The level of significance is based on the contrast test.

Microhabitats	1986/87	1987/88	Change (%)
1	16	4	–75 *
2	19	4	–79 *
3	27	35	30 ns
4	19	10	–47 ns
5	19	47	147 *

5. Discussion

The increasing trend of the crane population wintering in the study site was modelled by a 2nd degree polynomial function. The relative growth rates calculated using this function from 1978 to 1987 are too high to be due to successive additions caused by the annual recruitment of young birds to the colonizing population. The Common Crane has a low clutch size, late sexual maturity and a relatively low fledging success (Cramp and Simmons 1979, Johnsgard 1983). Thus, a large part of the colonizing birds must be newcomers that have earlier wintered farther south.

The yearly variation of Crane numbers around the increasing trend is related to autumn rainfall, which causes flooding of the heaths before the arrival of the cranes. The degree of flooding acts not only on the habitats used for roosting or during the day, but also on food abundance. Riols (1987) has noted that high autumn rainfall can increase the availability of food in maize fields for cranes in northern France, as it reduces the possibility of machine harvesting. Moreover, disturbances are limited when flooding is high, because access to the study area becomes difficult for humans and for predators such as the fox.

As noted by Salvi (1984), the presence of water in the cranes' sleeping quarters is not necessary, as the low heaths used are not always flooded. However, the marked and regular occurrence of the birds in permanent basins and in low flooded heaths shows that they are attracted to these shallow water areas. Similar observations have been made by Fernandez-Cruz (1981), Hernandez-Fernandez (1984), and Prange (1987) for *G. grus*, and by Lewis (1976), Lovvorn & Kirkpatrick (1981), Iverson et al. (1987) and Krapu et al. (1984) for *G. canadensis*. Lewis (1976) noted the preference of sleeping quarters surrounded by open spaces where good visibility gives the birds protection against predation. On most of the sites occupied in our study area (low heaths and some basins), the surroundings were very open; however, some highly frequented basins have recently been encroached upon by wooded heaths and visibility is often limited. Similar situations have been noted in the United States for *G. canadensis* (Lovvorn & Kirkpatrick 1981, Krapu et al. 1984). Krapu (1979, Krapu et al. 1982) considered that this type of situation is not favourable to cranes and suggested that the invasion of sleeping areas by bushes should be checked.

In daytime, cranes preferred low heaths, which are typical habitats, as described by Géroudet (1978). These are used as feeding grounds, which has also been mentioned by Riols (1987) and Kovacs (1987) for *G. grus* and by Krapu et al. (1984) and Iverson et al. (1985) for *G. canadensis*. Forty-five per cent of the birds observed in the low heaths of the study area were feeding. This proportion is comparable to that found by Krapu et al. (1984) for *G. canadensis* in prairie zones and about the same as that reported for groups using maize fields near the study area (58% ± 3%, Génard & Bereyziat 1988). There appears to be a complementary relationship between maize fields, where the cranes find high-calorie food (see Krapu & Eldridge 1984) and low heaths where they find foods capable of balancing their diet. Similar observations have been made for *G. canadensis* in the United States (Krapu et al. 1984, Krapu & Eldridge 1984). The low heaths, which were formerly maintained by grazing (Pinaud 1985), now survive thanks to controlled or accidental fires linked with military activities. Five microhabitats originating from fire can be distinguished in these heaths, forming an after-fire recolonization gradient. The recolonization by *Molinia* (last stage) is rapid, which seems to be a usual phenomenon (see Rey 1951, Clément et al. 1980, Forgeard & Touffet 1985). Only the microhabitats partly recolonized by low vegetation were favoured. The reason for this choice may be food-dependent: it should be easier for the cranes to find tubers or roots in low vegetation, which is also rich in the young grass shoots of which they are fond (see Géroudet 1978), while recently burned zones offer little food of interest.

In conclusion, this study emphasizes the importance of good management of the water level and of controlled fires to enhance the interest of the study area for cranes. Far from being an "ecological catastrophe", fire can be beneficial under certain conditions (Prodon 1987 a, b) and is currently an integral part of the management of some protected sites (Prodon & Fons 1980).

Acknowledgements. This study was carried out under the control of the Comité d'étude Grue Cendrée. We would like to thank the Fédérations Départementales des Chausseurs de la Gironde et des Landes for their cooperation. We would also like to express our thanks to the Civil Authorities, Police and Firemen of the C. E. L. who welcomed us to the Poteau military camp and were kind enough to report to us their observations of the Common Crane. Finally, we would like to thank P. Petit, who gave us the results of counts carried out since 1977. This study was partly funded by the E. E. C.

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