

# Numerical trends, habitat use, and activity of Greylag Geese wintering in southwestern Spain

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## Introduction

The Marismas (marshes) of the Guadalquivir (SW Spain) are the main wintering grounds of continental western European Greylag Goose *Anser anser* populations (e.g. Bernis 1964; Rooth 1971; Ogilvie 1978). Yet few studies have been conducted on the wintering of this species in that area. Sánchez *et al.* (1977) documented some general aspects of the ecology of Greylags, and Amat and García (1979) and García *et al.* (1980) reported monthly numerical trends throughout two wintering seasons. Midwinter counts were also undertaken for several years in connection with the programme of the International Waterfowl Research Bureau (e.g. Bernis 1972; Bernis & Valverde 1972; Araújo & García Rua 1973). Apart from the numbers very little is known about the wintering of Greylag Geese in the Marismas.

The Marismas floods are very shallow (water depth less than 1 m). Yearly variation in timing of autumn rains and amount of rainfall modify the extent and duration of winter flooding, and this has an important consequence on their use by Greylag Geese (Sánchez *et al.* 1977). In turn, the environmental conditions could affect activity budgets (Verner 1965; Paulus 1984), and thus the latter could be used to assess habitat conditions. All these aspects of the winter ecology are important in order to propose management and conservation measures of this Greylag Goose population.

Beside documenting the numerical trends of Greylag Geese wintering in the Marismas, the objectives of this study were to examine the influence of hydrological conditions on habitat use throughout the winter and during different winters, describe diurnal and monthly activity rhythms, and evaluate the influence of different hydrological conditions on those rhythms.

## Methods

### Numbers and habitat use

Monthly aerial censuses (October–March) of Greylag Geese present in the Marismas (for a general description of this area, see Valverde 1958) were carried out from 1977–8 onwards. The habitat types considered were: *Scirpus litoralis*-dominated areas, *Scirpus maritimus*-dominated areas, pastures (mainly natural grasslands), cultivated fields (autumn sown cereals), stubble ricefields, and others (e.g. lagoons parallel to a range of littoral dunes, areas with *Spartina densiflora*). The relative extent of different habitat types available to Greylags is presented in Table 1, but this may change from year to year according to flooding conditions.

### Activity

Observations on the activity of geese were conducted throughout the winter of 1981–2, and during January and February 1982, 1983 and 1984 in two areas within the Doñana National Park: the Biological and Guadamar Reserves. In these areas the geese mainly use the zones covered by *S. litoralis* and *S. maritimus*. The former species grows where the water level reaches a depth of 30–70 cm, whereas *S. maritimus* is found in shallower areas (10–40 cm).

Every 1.5 hours, from 08:30 until 17:30 hours (Spanish official time, GMT + 1 h), the activity of at least 200 geese (Burton & Hudson 1978) was recorded using a 20–45 x telescope. The activities were allocated to

**Table 1. Relative extent of different habitat types potentially utilizable by Greylag Geese in the Marismas under normal flooding conditions.** The total area is 48533 ha.

Habitat type	Percentage
<i>Scirpus litoralis</i>	11.4
<i>Scirpus maritimus</i>	16.8
Pastures	3.8
Cultivated fields	12.1
Ricefields	43.5
Others	12.4

five major types: feeding, resting, preening, vigilance, and others (flying, swimming, walking, drinking, agonistic behaviour, comfort movements other than preening). Only those birds in "extreme head up" posture (Lazarus & Inglis 1978) were considered as vigilant. The timing and number of geese flying to and from the roosting places under drought conditions were recorded.

Throughout the paper, differences between data were tested by means of  $\chi^2$ -tests.

## Results

### Numerical trends

The midwinter counts in the Marismas from 1971–2 onwards clearly show a considerable increase in the number of Greylags (Figure 1). During the first years of the past decade 15,000–25,000 geese were present in the Marismas, the number rising to 40,000 birds from the middle of the seventies, and to 60,000–75,000 from 1978–9 onwards. However, a decrease was recorded in 1980–1 and 1981–2; this was due to an exceptional drought in the first of these winters, which caused food shortage and as a consequence 10,000 Greylags died, mainly from starvation. Moreover, counts conducted in Morocco revealed the presence of more

Greylag Geese than in normal winters, suggesting that some birds moved southwards (Thevenot *et al.* 1982). Also, many geese were shot during the spring migration in central and north Spain, as well as in southwest France (Fernández-Cruz 1982). All these circumstances could have caused the numerical decrease recorded in 1981–2.

Monthly counts indicate that Greylags begin to arrive in late September–early October, are most abundant in December–January, and almost totally disappear in March–April (Figure 1). After unfavourable wintering seasons, such as 1980–1, about 300 geese are still present in May. Some birds (10–20), probably injured, remain through the summer.

### Habitat use

Figure 2 illustrates the proportion of Greylags in different habitat types throughout three wintering seasons, as well as the monthly amount of rainfall, which may be used as a rough index of the hydrological conditions of the area.

The winter of 1977–8 may be considered as normal. Just after arrival, most Greylag Geese concentrated on *S. litoralis* areas, which are the first ones to flood. However, as soon as other zones were flooded, the geese moved on to *S. maritimus*, whose rhizomes constitute the main food for

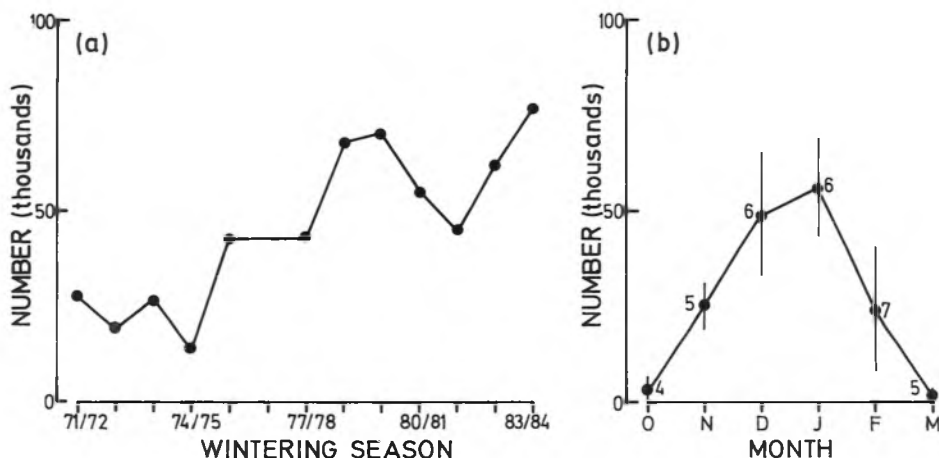


Figure 1. (A) Peak numbers of wintering Greylag Geese in the Marismas from 1971–2 to 1983–4; no counts were conducted in 1976–77. (B) Mean monthly numerical fluctuations of Greylags wintering in the Marismas. Vertical bars represent 1 S.E., and numbers beside points indicate the number of counts undertaken for each month from 1977–8 throughout 1983–4.

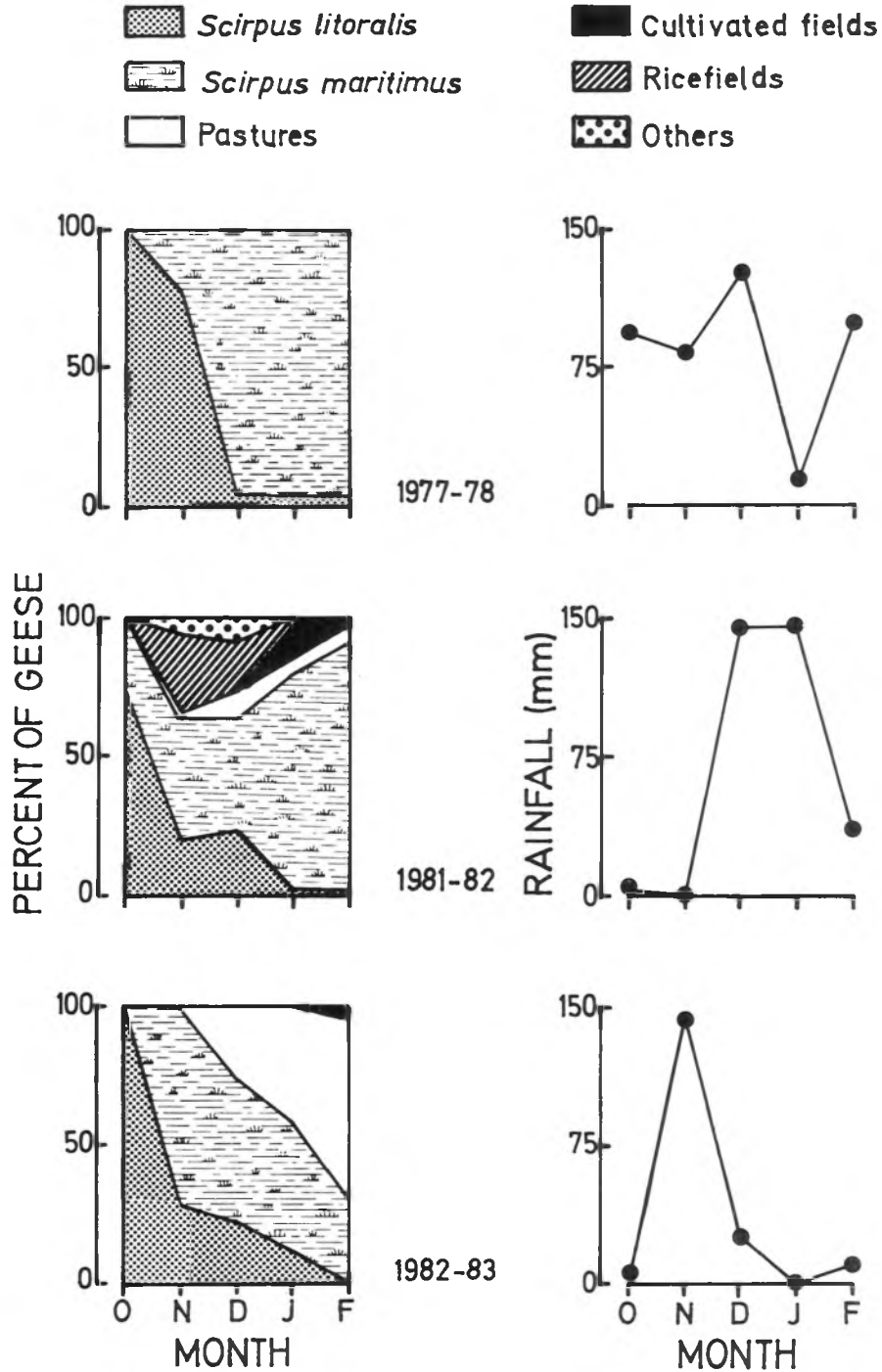


Figure 2. Monthly percentages of Greylag Geese in different habitat types, and monthly amount of rainfall in the Marismas for three wintering seasons.

Greylags wintering in the Marismas (Bernis 1964; Sánchez *et al.* 1977).

The situation in 1981–2 was quite different. In October, most geese concentrated on *S. litoralis* and *S. maritimus* areas which were artificially flooded. As the food was depleted in these areas and more geese arrived, many of them occupied other habitat types, mainly stubble ricefields where they probably fed on waste rice grains. Following heavy rainfall in late December, most geese were recorded in *S. maritimus* from January onwards. By the late winter some birds also utilized cultivated fields.

The pattern of habitat occupation during the first months of the winter 1982–3 was similar to that of other years, i.e. the geese were first recorded in *S. litoralis* areas, and then they moved on to some *S. maritimus* areas, when the latter flooded because of heavy rainfall in early November. Because of the lack of sufficient rainfall in the following months extensive areas of *Scirpus*

spp. dried up. The amount of rain was enough, however, to allow the development and maintenance of extensive pastures, hence their heavy utilization during late winter.

#### Activity

##### Diurnal rhythm

Feeding mainly occurs in the morning and afternoon, while the percentage of birds resting increases around midday. When the marshes are flooded, the geese rest mainly along the edges of the water bodies and on some islets, swimming to the feeding areas which are only 100–500 m away. When most of the Marismas are dry, the geese disperse from the roost flying 1–5 km to the feeding areas. Most departures take place just after sunrise (Figure 3), many birds returning to the roosting place between 13.00–16.00 hr to drink, preen and rest. A considerable

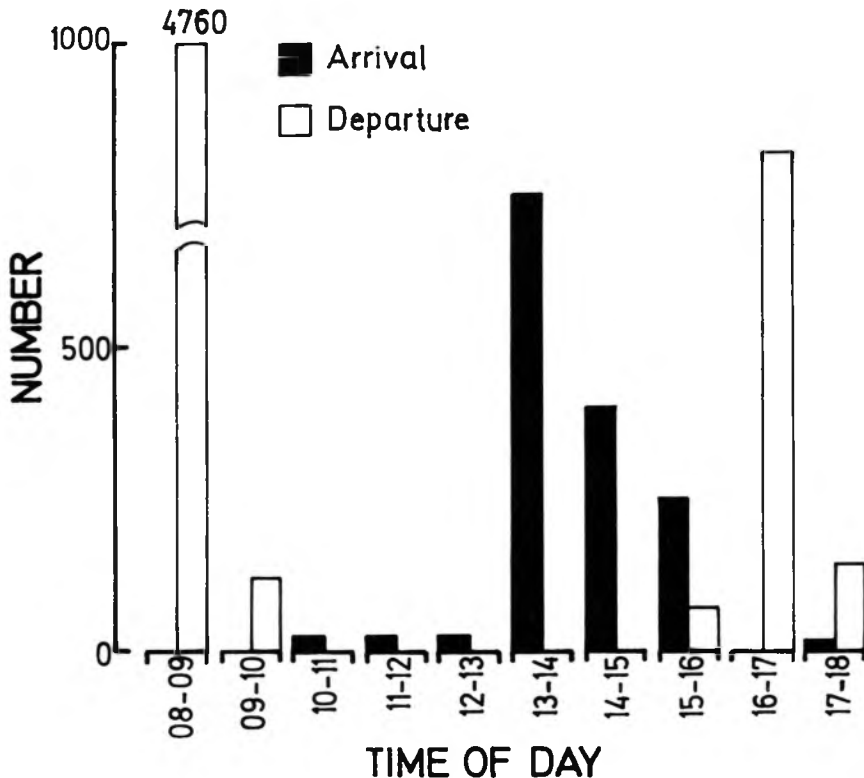


Figure 3. Number of Greylag Geese arriving to and departing from Mari López lagoon on 24 November 1981, according to time of day.

number again departs to the feeding grounds around 16.00–17.00 hr. Most birds return to the roosting place 0.5–1 hour after sunset. As the light conditions were then very poor, their number could not be estimated, hence the difference in Figure 3 between the number of geese arriving at and departing from the roosting place.

#### Seasonal variations

The percentage of birds feeding, preening and engaged in "other" activities increased throughout the winter 1981–2 (Figure 4), while that of geese resting and vigilant showed the opposite trend (all  $p < 0.01$ ). In December, the proportion of birds feeding was higher than in November or January; this may be related to the drought conditions prevailing in the first half of that winter. Under these circumstances, the feeding efficiency of Greylags decreases (Amat 1986), and therefore they should compensate for this by increasing the time devoted to foraging in order to maintain an adequate rate of food intake.

#### Effects of water regime

The hydrological conditions of the Marismas have some influence on the activity of wintering Greylag Geese. During normal flooding conditions, the geese preferentially feed on the smaller rhizomes. During drought conditions, in contrast, the geese use the same flooded areas throughout most of the winter at very high densities, so that the supply of the smaller rhizomes is depleted, and they then feed on larger rhizomes (Amat 1986), which seem to be less profitable (Amat 1983, 1986). It may therefore be expected that the Greylag Geese should spend more time feeding under drought conditions. Observations of activity at one site were conducted during January and February 1982, 1983 and 1984 (Figure 5). Considering the flooding conditions, 1983–4 was the best winter, because the Marismas flooded in mid-November and thus there was a good availability of feeding areas throughout most of the winter. In 1981–2 flooding did not take place until late December; on the contrary,

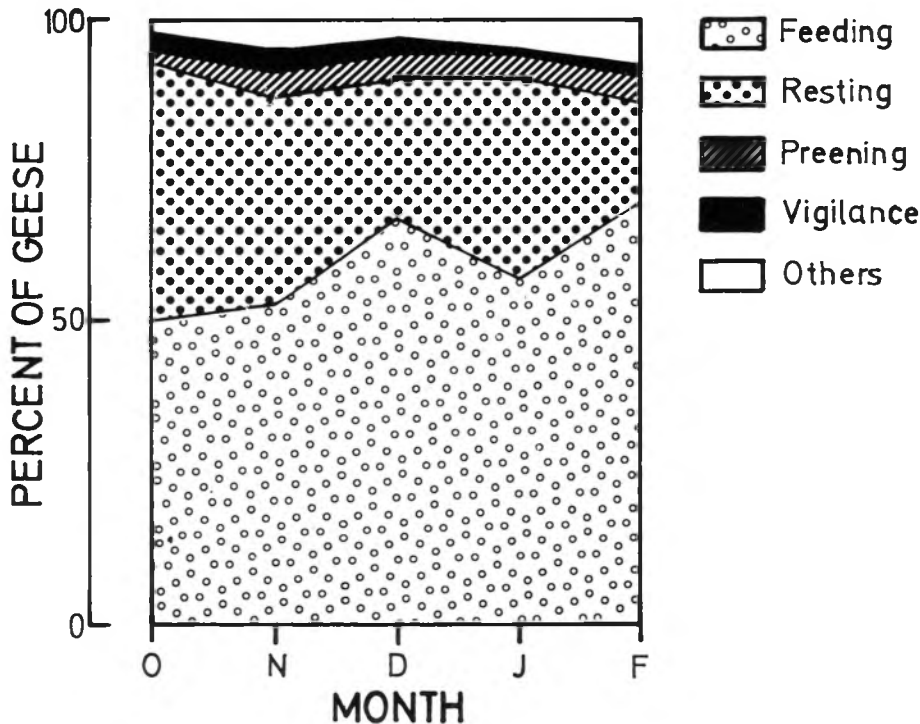


Figure 4. Diurnal activity of Greylag Geese in *Scirpus*-dominated marshes during the winter 1981–2.

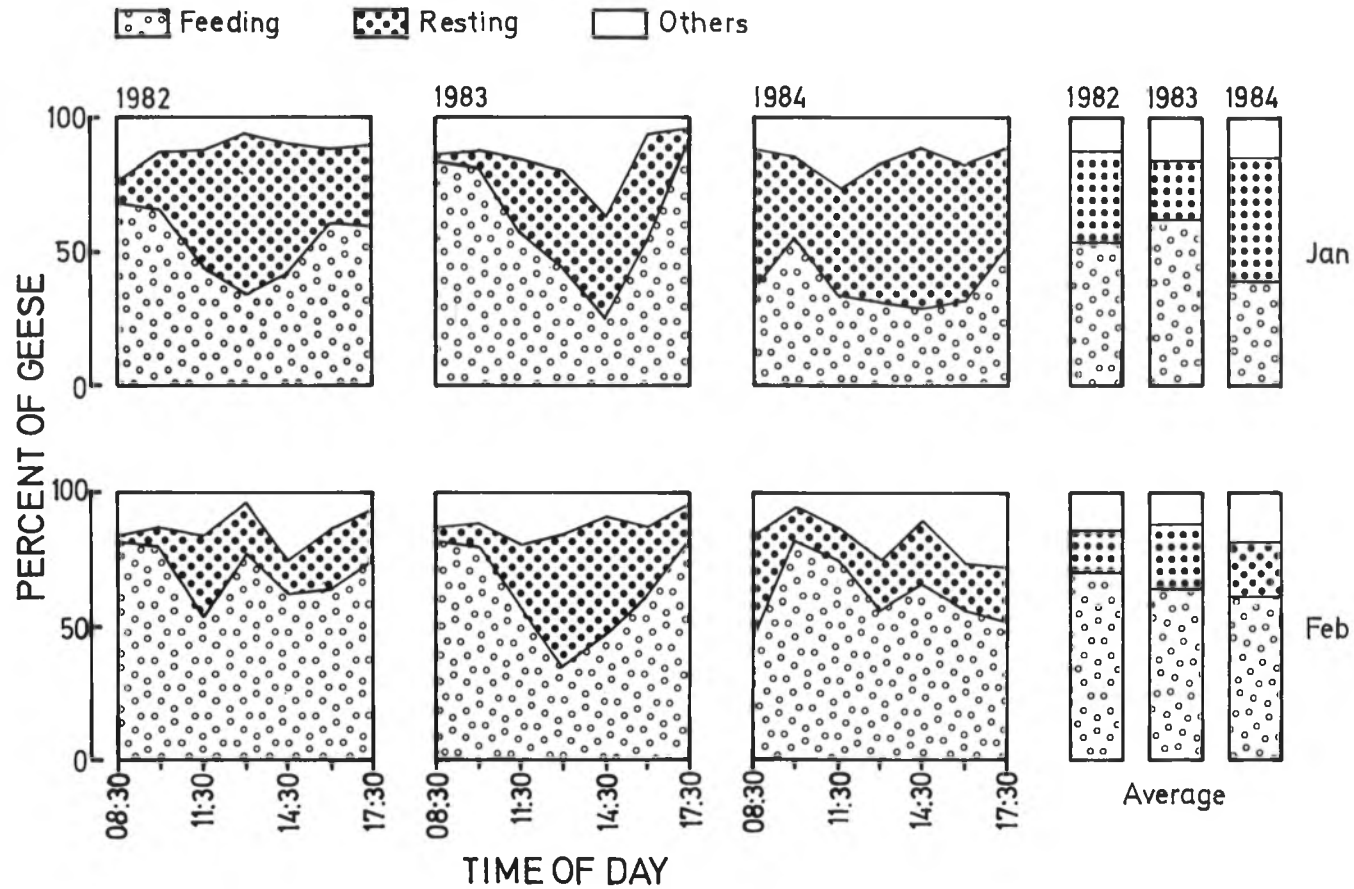


Figure 5. Diurnal activity of Greylag Geese in January and February 1982, 1983 and 1984. The category "others" includes locomoting, drinking, vigilance, and comfort and agonistic behaviour.

1982–3 was very dry. Results indicate that the better the hydrological conditions in the Marismas, the shorter the time spent foraging by Greylags ( $p < 0.01$ ).

## Discussion

### Numerical trends

A numerical increase of similar order of magnitude as that reported for Greylags wintering in the Marismas has also been noted for Greylags wintering in the British Isles (Ogilvie 1978). This increase has not been due to a distributional shift of the species; several authors have reported an increase of western continental Greylag Geese both in breeding and moulting localities, and in stopover areas along the migration corridor of Greylags wintering in the Marismas (Rooth *et al.* 1981; Essen & Beinert 1982; Karlsson *et al.* 1982; Fog *et al.* 1984; Madsen 1985). Protection of the breeding grounds and reintroductions in some areas formerly occupied by Greylags from which they disappeared because of human disturbance could have accounted for this increase of western European populations. But perhaps more important is that hunting pressure in the Marismas is at present lower than it was some decades ago.

### Habitat use

In the Marismas, during the first months of the wintering season, the Greylag Geese are mainly found in *S. litoralis*-dominated areas, these areas being the first ones to flood. However, following the rise of the water level, the geese move on to *S. maritimus* areas. Probably, under such circumstances the rhizomes of *S. litoralis* would be inaccessible to birds, even though they tried to reach them by upending, because of the greater water depth (cf. Burton & Hudson 1978).

Sánchez *et al.* (1977) indicated that, in the Marismas, Greylags mainly use the grasslands when most wetlands are dry; the results presented support this. However, in recent rainy winters (1983–4 and 1984–5) large flocks of geese were observed in extensive natural pastures of the Marismas, where they were not observed in previous rainy years. Hence, due to the great increase of the wintering population in recent years, there seems to be also a

population density effect operating on the selection of habitats by Greylag Geese. Probably, the saturation of the best feeding zones by large numbers of birds could lead to some of them shifting to suboptimal habitats (pastures). Similarly, in England an occupation of inland areas formerly not used by Brent Geese *Branta bernicla* has been noted following a considerable increase in this species (St. Joseph 1979). This is a very common response by many animal species under similar circumstances (Schoener 1971; Krebs 1978).

In the Marismas, the use of cultivated fields mainly takes place in the late winter, and this could be in relation with the consumption of growing cereals. Only a small proportion of the wintering population uses the cultivated fields adjacent to natural areas. The effect that such a utilization has on the subsequent cereal crop is not known. The damage to crops may be considerable under very drought conditions, such as November 1983. In this year there was no growth of *Scirpus* spp. or grasses because of a persistent drought. Furthermore *Scirpus* rhizomes had been depleted during the previous wintering season. Some flocks of thousands of geese were then observed feeding on recently sown cereal grain. A similar situation occurred in November 1981, but in this case a considerable proportion of the population used stubble ricefields instead (Figure 2). In this last case, damage was negligible, as the rice harvest was over. Other studies have also reported habitat switching by geese under adverse environmental conditions (McLandress & Raveling 1981b; Nilsson & Persson 1984).

Sánchez *et al.* (1977) pointed out that, in the Marismas, the Greylag Goose is very specialized in habitat use, and considered that the transformation of natural areas into agricultural ones could have a negative effect on the size of the wintering population. On the contrary, the present results suggest that habitat diversity could be important in order to allow the geese to respond to different environmental conditions (cf. Burger *et al.* 1983). In fact, although the Greylag Goose was formerly adapted to *Scirpus* habitats (Bernis 1964; Owen 1976), it has been shown elsewhere that some populations of this species have switched to other habitat types (Markgren 1963; Newton & Campbell 1973; Owen 1976; Dubbeldam 1978; Ouweneel 1979),

probably following the widespread destruction of *Scirpus*-dominated marshlands, thus indicating that the Greylag Goose seems to be rather adaptable in habitat utilization.

### Activity

#### Diurnal rhythm

The pattern of diurnal activity exhibited by Greylags in the Marismas closely corresponds with that found for this and other geese species elsewhere, in that feeding mostly occurs in the morning and late afternoon, whereas resting takes place around midday (see e.g. Owen 1972; Raveling *et al.* 1972; Loosjes 1974; Fruziński 1977; Frederick & Klaas 1982). However, in some areas the activity of Greylags is also influenced by tidal conditions (Loosjes 1974).

Although the diurnal activity patterns of geese populations are rather similar, there are important differences in the allocation of time into different activities, which may be related to the quality of their food (e.g. Fruziński 1977; Van Impe 1980; McLandress & Raveling 1981b). Geese feeding on grasses spend 80–90% of the daylight hours feeding (Owen 1972; Ebinge *et al.* 1975; Van Impe 1980; Summers & Grieve 1982), while geese feeding on the more nutritious underground plant organs only spend 30–50% of the time feeding (Loosjes 1974; Burton & Hudson 1978; Van Impe 1980; this study).

#### Seasonal variations

Throughout the winter, there was an increase of the importance of all activities, except resting and vigilance. Frederick & Klaas (1982) also reported seasonal variations in the activity of migrating Snow Geese *Anser caerulescens*, and found that habitat use changes and weather (temperature and wind) differences accounted for most of the seasonal variation. In the Marismas, it is thought that the influence of weather may be less than that reported for other geese populations wintering at other latitudes (Markgren 1963; Raveling *et al.* 1972; McLandress & Raveling 1981b; Burger *et al.* 1983), as the mean temperature in January (the coldest month) is 10°C and very strong winds are uncommon.

The seasonal differences in activity may

be in relation to the laying down of fat (see McLandress & Raveling 1981b) at the end of the winter for the spring migration (e.g. McLandress & Raveling 1981a; Gauthier *et al.* 1984), and also in relation to some aspects of the social system of the species. Therefore, during the pre-migratory period, the geese spend more time feeding at the expense of other activities. Metcalfe & Furness (1984) suggested for the Ruddy Turnstone *Arenaria interpres* that the additional risk of predation through spending less time vigilant would be compensated for by the increased rate of fat accumulation during pre-migratory periods. This explanation may be sufficient for sub-adult or adult geese without young. In the case of adult geese with young the decrease of the vigilance time should be facilitated because the feeding efficiency of young Greylags probably improves with age (see Lazarus & Inglis 1978) and also because the break-up of family bonds occurs in the late winter (Rutschke 1982). Of course, it may be argued that the time spent vigilant would be affected by a flock-size effect (Drent & Swierstra 1977; Lazarus & Inglis 1978); however, in the Marismas Greylag flocks were of similar size throughout most of the winter (Table 2).

**Table 2.** Mean monthly size of Greylag Goose flocks recorded during aerial censuses in the Marismas.

Month	Mean $\pm$ S.D.	N
October	15 $\pm$ 15	16
November	125 $\pm$ 140	169
December	164 $\pm$ 186	357
January	141 $\pm$ 300	443
February	120 $\pm$ 222	282

#### Effects of water regime

Under drought conditions the Greylags spent more time feeding, perhaps because of the decrease of their feeding efficiency. They would obtain more food, but also would spend more energy in obtaining it. The energetic costs associated with the extraction of the larger rhizomes eaten under drought conditions are greater than those required to extract the smaller rhizomes (cf. Amat 1986). Consequently, despite the increase in time devoted to



foraging under adverse environmental conditions, the foraging return of Greylags would be lowered because of the lower profitability of the food available under such conditions.

#### Conservation measures and research needs

The Greylag Goose population wintering in the Marismas is steadily increasing at present. Perhaps as a consequence of this, a considerable proportion of the population has shifted to habitats which were not traditionally used under normal flooding conditions. This suggests that the carrying capacity of *Scirpus* habitats might have been reached, and therefore that the population would be seriously stressed under extreme drought conditions, such as 1980–1 when 10,000 birds starved as a consequence of food shortage (cf. Fog *et al.* 1984).

Because of agricultural transformations, the Marismas have suffered serious disturbance of the water inflow regimes, which accentuated the conditions prevailing in years with severe droughts. This prompted the initiation of a project aimed at the restoration of part of the water inflow. By means of this restoration, extensive areas of natural marshland will be flooded under adverse environmental conditions, and this will surely alleviate the situation of dry years. However, extensive areas of Marismas adjacent to protected marshlands are being transformed for agricultural purposes. If the population increase continues, the geese could occupy these agricultural fields, as the carrying capacity of natural areas is being reached. Furthermore, during drought conditions there is likely to be a more severe utilization of agricultural fields by geese, so that conservation problems will probably arise because of damage claims by farmers.

In order to propose long-term conservation measures it is necessary to know some aspects of the population dynamics related to habitat use. For instance, it would be interesting to document if the recent occupation of marginal areas (grasslands) due to the population increase has any

effect on the breeding success of the birds using these areas. The recent study of Gauthier *et al.* (1984) points in the direction that the breeding success of geese using alternative habitats could be lower than that of birds using traditional ones.

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#### Summary

The size of the Greylag Goose *Anser anser* population wintering in the Marismas of the Guadalquivir (SW Spain) has increased from 15,000–25,000 birds in the early 1970s to more than 75,000 birds in the middle of the 1980s. Under normal flooding conditions, most Greylags are found in *Scirpus*-dominated zones adjacent to the roosting places; under drought conditions the geese also use other habitat types, such as cultivated fields (autumn sown cereals and ricefields) and grasslands, 1–5 km from the roosting places. Probably as a consequence of the population increase, the use of grasslands has become more prominent in recent years, even when these are rainy. Feeding mostly occurs in the morning and late afternoon, and resting mainly takes place around midday. Under drought conditions, the geese spend more time feeding than under normal flooding conditions; yet their foraging return would be lower because of the lower profitability of the food available under such conditions. Throughout the winter, there is an increase in feeding at the expense of resting and vigilance; this may be in relation to the need for fat accumulation to face the spring migration. For adult birds this would be facilitated by the relaxation of their parental duties in the late winter. The recent increasing use of grasslands may indicate that the carrying capacity of *Scirpus* habitats has been reached, and therefore that the population would be seriously stressed under extreme drought conditions, such as those of the winter 1980–1, when 10,000 Greylags died mainly from starvation.

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