Activity budget of an increasing wintering population of Greylag Geese *Anser anser* in southern France

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The wintering of Greylag Geese *Anser anser* in the Camargue, southern France, is a relatively recent phenomenon. Weekly counts carried out since 1980 on the St Seren Marsh, one of the most important sites in the Rhône delta for Anatidae, showed an exponential increase of the number of wintering geese (32% per year). More than 1,200 Greylags were recorded at St Seren during the winter of 2001-2002, representing nearly 75,000 goose-days throughout the season. The main daily activities of the geese were resting and feeding, which occupied nearly eight hours of the 10-hour daylight period. During the day, geese fed preferentially in the morning and rested in the afternoon. Time allocated to resting was significantly higher at the end of the season (December to February) than at the beginning (October and November). Attention should be paid to the dynamics of wintering geese in the Camargue because potential outcomes of the increase in goose numbers could be a a significant impact on the marsh vegetation and intrusion into cultivated areas with concomitant depredation problems.

Key Words: Greylag Goose, population size, activity budget, Camargue

In the second half of the twentieth century, spectacular increases in goose numbers were observed in Europe and North America (Ankney 1996; Madsen *et al.* 1999). These increases have been related to restrictive harvest regulations, the creation of refuges, and the opportunistic exploitation of agricultural lands by geese in staging and wintering areas (van Eerden *et al.* 1996). In Europe, the Greylag Goose is the most widely dis-

tributed species: there are at least seven native populations of this species using known and less well known migration routes (Kampe-Persson 2002).

The origin of the Greylag Geese wintering in southern France is currently unknown. The Camargue is situated between two well-known flyways for this species, the East Atlantic (Andersson *et al.* 2001) and the Central European (Dick *et al.* 1999). Populations in these flyways have increased markedly in the last few decades, the Norwegian to 70,000 birds, the West Baltic to 250,000-325,000 birds and the Central European flyway to >40,000 birds, and they continue to increase (Madsen *et al.* 1999; Delany & Scott 2002; Kampe-Persson 2002).

The Camargue is one of the most important areas in Europe for wintering waterbirds (Grimmet & Jones 1989; Tamisier & Dehorter 1999; Heath & Evans 2000). The St Seren marsh, located in the central part of the Rhône delta, represents one of the main wintering areas for waterfowl in the Camargue, being a key diurnal roosting site (Duncan *et al.* 1982; Tamisier & Dehorter 1999). Greylag Geese have wintered in the Camargue only relatively recently, but an increasing number of geese have been observed at St Seren (Walmsley 1988; Kayser *et al.* 1992).

The objectives of this paper are (1) to characterise the annual and seasonal variations in the wintering population of Greylag Geese on the St Seren marsh since 1980, and (2) to quantify the diurnal activity budget of the geese, specifically the time allocated to feeding, to better evaluate the potential impact of the birds on the marsh (Gauthier *et al.* 1988; Amat 1995; Jefferies & Rockwell 2002).

Methods

Study area

The Camargue is located in the delta of the Rhône (43°30'N, 4°30'E), on the Mediterranean coast of southern France (**Figure 1**). This deltaic complex, covering 1,450km^2, is a mosaic of fresh, brackish and saline wetlands within an intensive agricultural landscape (Tamisier & Grillas 1994). Natural habitats represent less than 40% of the total surface area (Tamisier 1992).

The St Seren marsh (70 ha) is located in the central part of the voluntary nature reserve of the Tour du Valat (**Figure 1**). As climatic conditions are typically Mediterranean (Heurteaux 1969), this marsh fills naturally with autumn rains and generally dries up in June (Duncan *et al.* 1982; Pineau 2002). However, since 1978 the water regime has been artificially managed in order to ensure a short summer drainage period before re-flooding at the beginning of August (Sinnassamy & Pineau 1996). During the winter of 2001/2002 the water level remained low due to poor autumn rainfall, thereby assuring the geese of maximum access to food. The vegetation is dominated by *Scirpus maritimus*, which covers more than

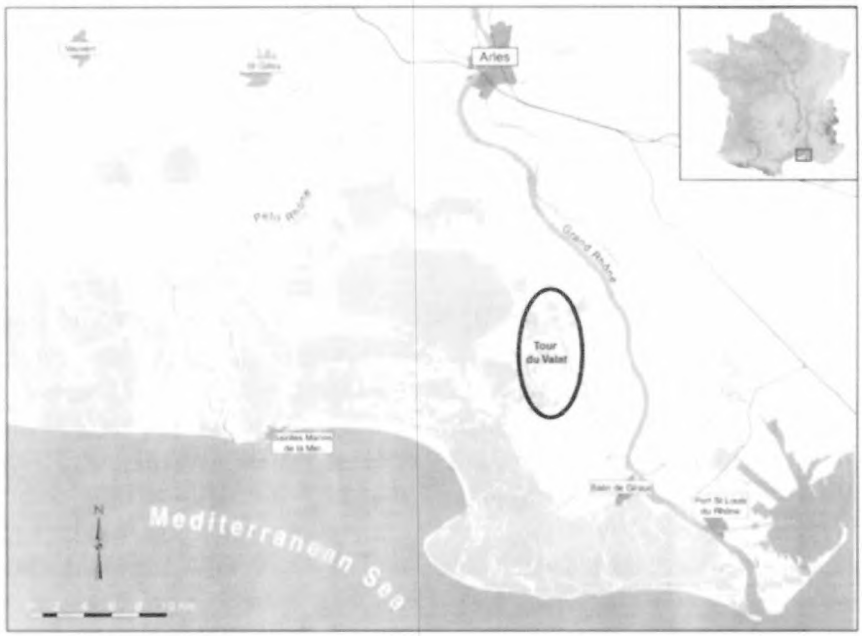

Figure 1. Location of the study site in the Camargue, southern France.

50% of the marsh, with sparse growth of *S. lacustris, S. littoralis* and *Aeluropus littoralis* (Aveline 1996). The St Seren is an important wintering area for dabbling and diving ducks, with peak numbers of up to 20,000 Anatidae using it as a diurnal roost (Duncan *et al.* 1982; Tamisier & Dehorter 1999).

Goose counts

Since 1980, weekly counts of geese on the St Seren marsh have been carried out from an observatory, using telescopes (x20-60). These counts represent minimal estimates because there are some sections of the marsh (<10%) that are not visible from the observatory. The number of goose-days per winter was calculated according to the following formula:

$$\sum_{i=1}^{n} geese_i+(((geese_i+geese_{i+1})/2)*(date_{i+1}-date_i-1))$$

where n is the number of days within a weekly count, geese is the number of geese surveyed, and date.

Activity budget

Observations of geese were conducted once a week from October 2001 to February 2002. Daily activity budgets were compiled by scan sampling conducted every 30 minutes (Altmann 1974) from 0800-1800h, maximum, depending on the time of sunset. Each individual was assigned to one of the following categories:

- Feeding: head lower than horizontal
- Resting: sleeping, generally with the bill under the wing
- Vigilance: head and neck drawn up
- Displacement: walking or swimming
- Preening: smoothing the plumage with the bill

In order to minimise observer bias (Gibbons *et al.* 1996), only two persons carried out the observations; the two observers carried out morning and afternoon scans alternately.

Each goose was associated with one of three classes of water level (dry ground, <5cm of water (legs visible), and >5cm of water).

Statistical analyses

Scans were grouped into three periods, 0800-1100h, 1130-1500h and 1530-1800h, on a monthly basis. Time budgets are presented as percentages, but were arcsine-transformed for analyses (Sokal & Rohlf 1995). As the distributions of residuals were normal, the effects of hour and month on the activities were tested using one-way ANOVA. The differences between classes were evaluated with Bonferroni-adjusted post-hoc tests.

Results

Goose counts

During the 1980s, fewer than 50 geese were counted each winter on the St Seren marsh (**Figure 2**). Numbers increased to a few hundreds in the 1990s, reaching more than a thousand in the winter of 1999-2000. Geese have also staged in the area for longer periods in recent winters (**Figure 3**). The number of goose-days fits well with the exponential growth function (F=87.23, df=1&20, r^2=0.81, P<0.001), indicating an annual growth rate (λ=exp r) of 1.32 (95% CI=1.24-1.40). During the last five winters, geese have been observed from August to March, with maxima in January (**Figure 3**).

Activity budget of the geese

The main activities of the geese were resting and feeding (**Table 1**). Between 65% and 90% of the time was allocated to these two activities, corresponding to a mean of eight hours per daylight period throughout the season. On a daily basis, feeding and resting were inversely correlated (**Table 2**). Geese fed more in the morning (F2,299=6.19; P=0.002,) and rested in the afternoon (F2,299=11.62; P<0.001). There were significant differences in time spent feeding during the season (F4,299=2.66; P=0.03), with a lower proportion in February than in November. The opposite trend was observed for resting (F4,299=18.37; P<0.001). Geese spent more time preening in October

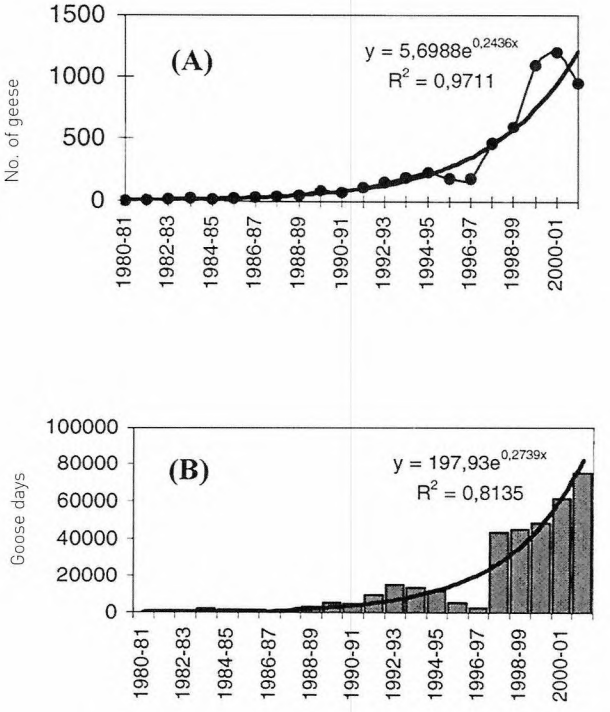

Figure 2. The annual maximum number of Greylag Geese counted in winter on the St Seren Marsh, Camargue, southern France 1980-2002 (A) and associated number of goose-days (B). Equations were computed taking the winter of 1980-81 as year 1.

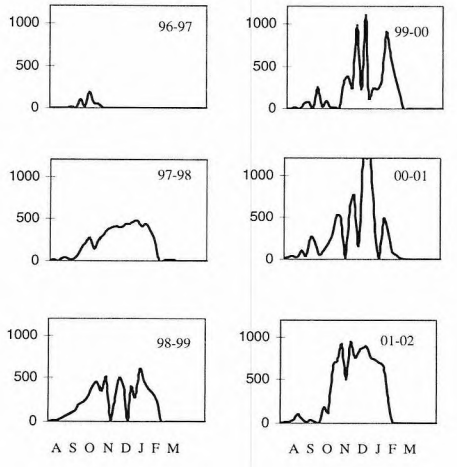

Figure 3. Weekly counts of Greylag Geese wintering on the St Seren Marsh, Camargue, southern France, 1996-2002.

Table 1. Percentage of daylight hours (0800-1800h) spent in each activity by Greylag Geese on the St Seren Marsh, Camargue, southern France, from November 2001 to February 2002. Number of scans used to compute the means are indicated (n) along with the total number of individuals (*i*).

	October	November	December	January	February
	(n=70) (*i*=2640)	(n=70) (*i*=14820)	(n=43) (*i*=18950)	(n=63) (*i*=42609)	(n=53) (*i*=21585)
Activity	Mean±S.E.	Mean±S.E.	Mean±S.E.	Mean±S.E.	Mean±S.E.
Feeding	44.2±3.8	50.0±3.5	45.0±3.5	47.7±2.8	34.7±3.2
Resting	20.9±3.0	28.6±3.1	44.1±3.7	41.7±2.6	51.0±3.5
Vigilance	3.3±1.0	0.8±0.2	0.9±0.2	0.3±0.1	0.4±0.1
Preening	11.6±2.0	5.9±1.0	2.3±0.5	2.3±0.5	2.6±0.4
Displacement	20.0±3.0	14.7±1.9	7.7±1.1	8.0±1.6	11.3±1.3

Table 2. Percentage of time spent feeding and resting by geese according to time of the day. Data from scan samples on the St Seren Marsh, Carmague, southern France, October to February, during the wintering season 2001-2002.

	(n=number of scans)	Feeding	Resting
		Mean±S.E.	Mean±S.E.
[0800-1100 h]	(n=100)	50.3±2.8	28.4±2.6
[1130-1500 h]	(n=123)	44.0±2.4	38.0±2.1
[1530-1800 h]	(n=76)	36.1±2.9	45.3±3.0

and November than during the other months ($F4,299=9.25$; $P<0.001$). Vigilance was a minor activity throughout the season, but significantly more time was devoted to this activity in October and December ($F4,299=4.37$; $P=0.002$). Locomotive activities were less important in January than during the rest of the winter ($F4,299=3.55$; $P=0.007$).

For resting, Greylag Geese appeared to favour areas where water levels were less than 10cm. Approximately 30% of the individuals sampled resting were observed where the water level varied between 0 and 10cm, with 20% resting on dry areas without vegetation.

Discussion

The St Seren marsh includes numerous hidden places where geese were not observable from the observatory, hence counts are minimal values of the size of the wintering population.

The recent appearance of Greylag Geese in the Camargue is most likely related to the increase in the breeding populations on the East Atlantic and Central European flyways (Kampe-Persson 2002). The destruction of traditionally favourable areas for wintering geese, such as Lake Ichkeul in Tunisia (E.R.I. 1999), or displacement from other North African sites, such as the wetlands of El Kala in Algeria or Sebkhet Sejoumi in Tunisia (Smart 2002), could have reinforced the role of St Seren as a wintering site for geese. The fact that the geese have staged for longer periods and that staging has been more consistent throughout the winter in recent years indicates the increasing fidelity of these birds to the marsh. Elsewhere in France, increasing numbers of Greylag Geese have been reported at the Orx marshes in the west and Lac du Der in the east (Fouquet 1991; Mouronval *et al.* 1996; Delprat *et al.* 2001;).

The observations of Walmsley (1988) need to be validated to confirm that the birds currently using the St Seren come from the same population as those seen here in the early eighties. The use of satellite telemetry could provide some answers to this question (Gudmundsson *et al.* 1995; Lorentsen *et al.* 1998). Identifying the origin of the Camargue wintering geese and improving our knowledge of the demography of this population from the breeding grounds may help to make predictions about their future in southern France.

The diurnal activity budget of Greylag Geese on the St Seren marsh is similar to results found in other studies in similar habitats. According to Loosjes (1974) and Amat (1986), feeding and resting were most important in the morning and at mid-day, respectively. According to Amat (1986), the time allocated to feeding is strongly correlated with the quality of the food. In feeding sites dominated by herbaceous plants, 80-90% of the birds' time is devoted to feeding. This is reduced to only 30-50% at sites where the diet is constituted mainly of the subterranean parts of plants. On the St Seren marsh, dominated by *Scirpus maritimus*, grubbing is important (L. Desnouhes, pers. obs.) and it was found that the geese spent 45% of their time feeding.

In winter, geese are known to spend nearly three quarters of the day feeding and resting (Amat 1986; Bredin *et al.* 1986; Tamisier *et al.* 1987; Durant 2001; this study). Unlike Amat (1986), who observed Greylag Geese in the delta of the Guadalquivir, this study found that resting was more important at the end of the winter than earlier in the season. This corresponded more closely with observations made at Lake Ichkeul (Bredin *et al.* 1986). At St Seren, it was found that geese fed for nearly five of the 10 hours of daylight. The nocturnal

activity of geese in the Camargue is currently unknown, but it has been shown elsewhere that geese can also feed extensively during the night, especially when diurnal disturbance is significant (Newton & Campbell 1973; Sanchez *et al.* 1977).

The impact of grubbing by Greylag Geese on the dynamics of the vegetation has been monitored at many sites (Kvet & Hudec 1971; Amat 1995; Esselink *et al.* 1997; Bakker *et al.* 1999). Although goose grazing pressure (1,070 goose-days/ha) actually measured on the St Seren marsh appears low compared to that recorded in other areas (Loosjes 1974; Owen 1982), it could, nevertheless, have a negative impact on the vegetation dynamics, especially if the number of geese continues to increase at the present rate. In the Netherlands, over exploitation of *Scirpus* habitat by geese has led to their shifting to cultivated areas to feed (Esselink *et al.* 1997), with a potentially severe impact on winter cereals (Kirby *et al.* 1999). This is not yet the situation in the Camargue, but some geese have been observed feeding on fields of rice stubble (Massez, pers. comm.). This behaviour could become more prevalent in the future if wintering populations continue to increase.

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