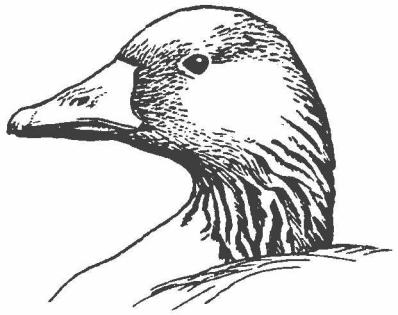
Moulting Greylag Geese *Anser anser* on the Danish island of Saltholm; numbers, phenology, status and origins



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In recent years, the Danish island of Saltholm has become the second-most important moulting site for Greylag Geese in northwest Europe. Numbers present on the island increased rapidly towards the end of May and peaked in mid-June, with a maximum of 9,100 Greylags counted in 1994. Goose numbers declined rapidly after early July, although there was a lag between their departure from Saltholm and the build-up of numbers at monitored resorts in adjacent parts of Sweden. During the settlement phase, Greylags fed for a substantial part of daylight hours, but during the peak of moult, they fed exclusively at night when they came ashore from daytime offshore roosting areas. Based on the presence of individually marked birds, the moulting population was mainly composed of young non-breeding birds from adjacent areas in Denmark and Sweden. It is suggested that Saltholm has become an important moulting site because of the availability of plentiful food resources, the absence of terrestrial predators and restricted human activity. In addition, the population from which the Saltholm birds are recruited has increased, and it is suggested that competition in the breeding areas may have displaced younger, non-breeding individuals to this new moult site.

Keywords: Greylag Geese, Denmark, Sweden, Moult, Feeding, Diurnal Rhythms

The northwest European population of Greylag Geese *Anser anser* comprises some 130,000 birds breeding throughout Scandinavia, Poland, The Netherlands, Belgium and France (Madsen 1987). This population represents approximately one third of the total world population of the species, which also breeds in Iceland, northern Scotland, central and northeastern Europe into Russia (Madsen 1987, Rose & Scott 1994).

Prior to wing moult, many non-breeding Greylag Geese undertake a moult migration to a few traditional areas (Paludan 1965, Lebret & Timmermann 1968, Hudec & Rooth 1970, Rutschke 1982). Here, flight feathers are shed and renewed, making the geese completely flightless for three to four weeks. Several regularly used moulting sites have shown dramatic changes in numbers and a few have been abandoned completely during recent years (see Madsen 1987).

In Europe, the distribution of Greylag Goose moulting sites is reasonably well documented (**Table 1**), the numbers of important sites are few, but their value for the well-being of the population as a whole is considerable. The development of a new moulting site on the island of Saltholm, situated in Øresund between Denmark and Sweden (**Figure 1**), is therefore of considerable interest. Although Greylag Geese occurred in spring and autumn on Saltholm earlier this century, they were not recorded breeding on the island until 1959 (Svendsen 1935, Jensen 1987). Currently, between 30 and 110 pairs nest on the island (Jensen 1987, Andersen–Harild 1993), but the concentration of moulting geese is even more recently established, with 1,242 Greylag Geese counted in the Øresund area on 1 August 1990 after the completion of moult, 2,500 counted on 6 June 1991, and 6,300 in mid-June 1992 in the southeastern corner of Saltholm (P. Andersen–Harild pers. comm.).

With the prospect of the development of a fixed road/rail link across Øresund,

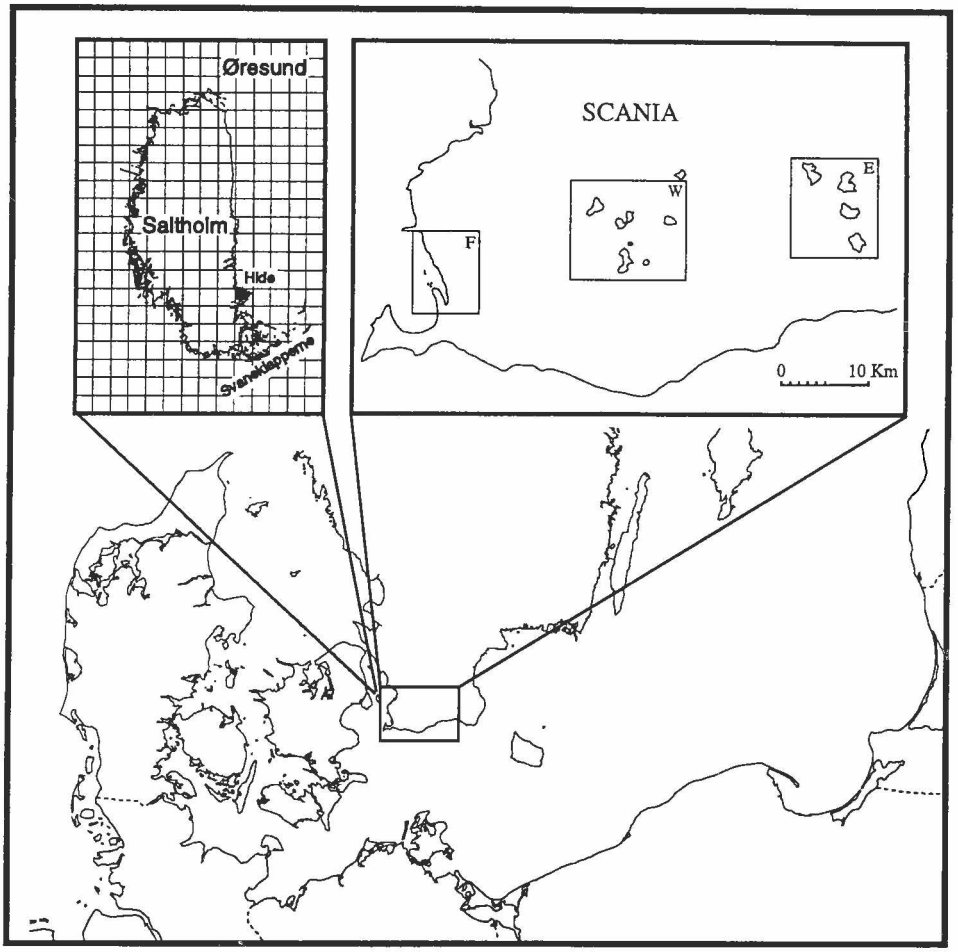

Figure 1. Location maps, showing the position of Saltholm in Øresund, between Denmark and Scania, Sweden. Detailed map of the island of Saltholm, shows 500 x 500 m UTM grid used to record bird distributions and the position of the observation hide. Detailed map of SW Scania study area in Sweden shows the distribution of count areas surveyed after the moult period 1994. F=Foteviken area, W=Western Lakes, E=Eastern Lakes area.

linking Sweden and Denmark by tunnel and bridge, it was necessary to determine the precise size, status and ecology of moulting geese on the island, which is situated some four kilometres from the proposed route of the link. The present paper analyses the numbers of Greylag Geese moulting at Saltholm, their activity, distribution and phenology of use of the island and determines the origin of moulting birds through the resighting of individually marked birds.

Study Area and Methods

Since the moulting Greylag concentration is a relatively recent phenomenon, there is little historical information relating to the build-up of numbers, duration of stay and dispersal of geese after the flightless period. To assess the phenology of moult, an aerial survey of Øresund was carried out in 1993 and 1994 to describe the build-up, duration and decline of Greylag numbers on Saltholm and adjacent coasts of Øresund. Flights were carried out twice a month before, during and after the moult period as weather conditions permitted. Flight routes and count sectors were standardised for each count, using aerial survey techniques described in Komdeur *et al.*

Table 1. Distribution of concentrations of moulting Greylag Geese exceeding 500 individuals in Europe (adapted from Madsen 1987, Zijlstra *et al.* 1991 and Andersson 1992).

Site	*n*	Period	Source
Oostvaardersplassen, Netherlands	60,000	1993	M. Zijlstra (pers. comm)
Saltholm, Denmark	9,100	1994	This study
Vega, Norway	6,000	1985	Follestad *et al.* 1988
Gotland, Sweden	5,400	1974–79	von Essen & Beinert 1982
Froya, Norway	5,200	1985	Follestad *et al.* 1988
Maribosøerne, Denmark	3,600	1991	Jørgensen *et al.* 1994
Saltbækvig, Denmark	2,600	1992	Jepsen *et al.* 1993
Slonsk, Poland	2,000	1980	Gromadski & Majewski 1984
Vejlerne, Denmark	500	1992	Jepsen *et al.* 1993

(1992) and trained observers (always including JPH). Aerial counts are presented as the totals for Saltholm as well as the adjacent Swedish and Danish coasts.

Saltholm is a flat island seven kilometres long, by three kilometres wide, predominantly covered in saltmarsh and rough grassland vegetation. Although lunar diurnal tides are of small magnitude (less than 30 cm), wind action can cause large scale changes in water level and so the island is subject to infrequent inundation, especially during winter. The coastal fringe supports lower saltmarsh communities of *Puccinellia maritima, Salicornia europaea, Artemesia maritima, Sueda maritima and Plantago maritima*, but grades inland into halophytic grassland with abundant *Festuca rubra, Juncus gerardi* and *Agrostis stolonifera*. The highest parts of the island are covered with tussocky grassland dominated by *Festuca arundinacea* and *Agropyron repens*. The whole island is grazed by sheep and cattle in summer, when some enclosed areas are cut for hay.

As part of extensive studies of the ecology of the geese, daily ground counts were undertaken during fieldwork on the island of Saltholm during late May to early July in 1993 and 1994. Goose counts were carried out from a purpose-built hide positioned on top of the roof of the disused telegraph station in the southeastern corner of the island (**Figure 1**). Goose distribution was assigned to UTM grid 500 x 500 m squares to describe their numerical distribution (**Figure 1**). Maximum daily counts were obtained to describe the phenology of moult for the geese.

Ground counts were organised in Scania during July-September 1994 to assess the dispersal patterns of geese departing from Saltholm eastwards to Sweden (**Figure 1**), given the results of the aerial surveys in 1993. Three major Greylag areas were counted on a regular basis to assess changes in numbers at the different resorts and to search for individually marked birds. Observations were carried out at Foteviken (an important coastal area south of Malmö), the Western Lakes area (around 55°30'N 13°15'W, see Nilsson & Persson 1992 for details) and the Eastern Lakes area of southwest Scania (**Figure** 1).

Time expenditure of goose flocks was compiled by instantaneous sampling of behaviour of all geese present in scans of flocks (Altmann 1974) throughout the 24 hour period, recording activities according to the following categories: forage, rest, feather care (including preen, bathe and wing-flap), walk, swim, alert. Budgets were compiled during the hours of darkness with a Pilkington PPE Kite Mk.4 50 mm night scope. Scans were carried out in three major habitats: (i) feeding areas on the Saltholm mainland, (ii) the shallow inshore waters and (iii) the roosts on the islets of Svaneklapperne. Since it was impractical to scan the entire moulting population in all habitats, scans were sampled from each habitat in a period of five minutes and the mean proportion of time allocated to each activity in each habitat calculated for the hours when data were collected. In addition, the position of all geese was recorded within 500 x 500 m grid squares every hour on as many days as practical (generally five to fifteen day intervals). Each square was then designated as mainland (more than 50% land surface), water (less than 50% land surface) or

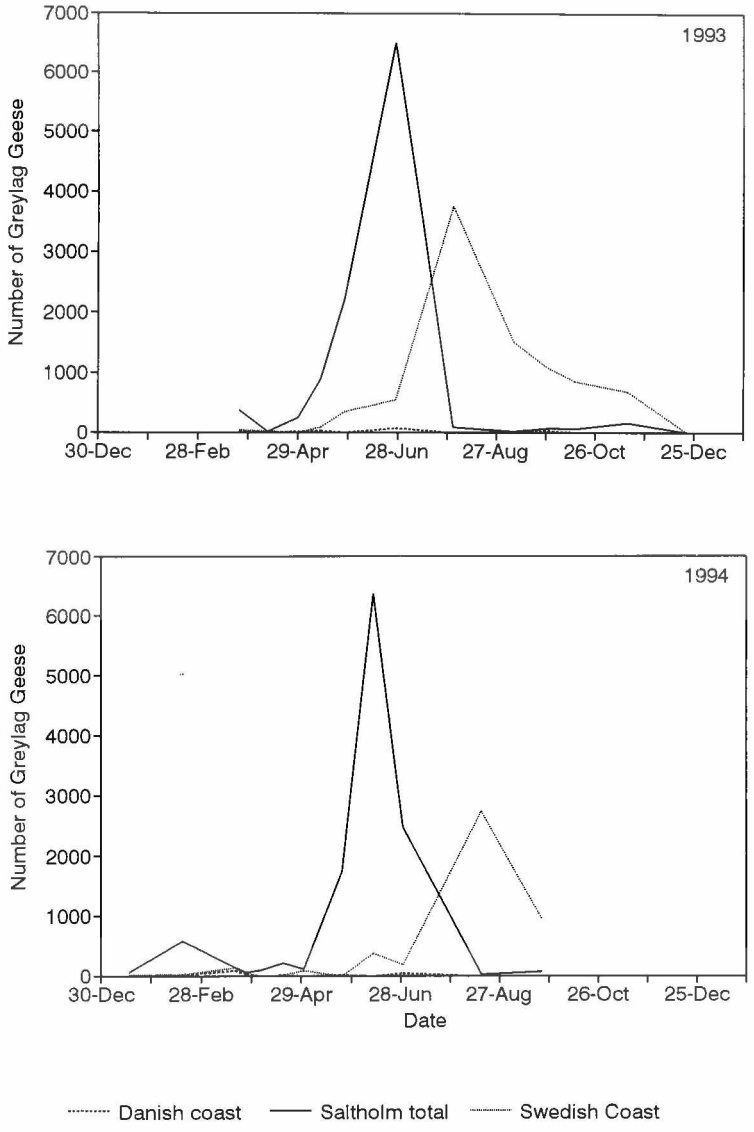

Figure 2. Summary aerial counts of Greylags in the entire Sound area between Denmark and Sweden, 1993 (upper) and 1994 (lower).

islets for the purposes of distribution analysis. Percentage activity budgets were then compiled by combining habitat activity scores with the bird distribution between habitats.

Since moulting aggregations of geese frequently draw individuals from widely separate sectors of the breeding population, some attempt was made to describe the origins of Saltholm moulters. Several schemes operate in Poland, Germany, The Netherlands, Sweden, Norway, Denmark, Britain and Iceland at present which involve the capture and individual marking of Greylag Geese (such as coloured leg

rings and neck-collars). Time was therefore devoted to searching for such individuals throughout the study.

Daily observations of moult scores were compiled during fieldwork, ascribing the extent of flight feather growth to moult stages (see Piersma 1987, 1988 for similar techniques on Great Crested Grebes *Podiceps cristata*). Observations were made using 20–60x telescopes, recording the extent of primary flight feather development on wing-flapping geese. Six moult states were distinguished from zero (no visible primary feathers at all) to five (full grown primary feathers). The moult stage of individual geese was recorded when a view of wing-flapping behaviour was sufficient to enable a score to be made and values were pooled for each day, based on sampling in the morning and evening when birds emerged from the water. Abdominal profile index (API) scores, a subjective score of the extent of fat deposits in the abdomen, was used as an index of body condition (Owen 1981, van Eerden *et al.* 1991). As many individuals were scored in the field as possible and values pooled for each day.

Results

Aerial survey counts

Aerial survey counts from 1993 and 1994 are summarised for Saltholm and Øresund as a whole in **Figure 2**. Overall numbers present in Øresund increased rapidly from mid to late May, concentrated on Saltholm itself. There was little evidence of a build-up of numbers on mainland coasts prior to the movement to the island for the main period of the moult (**Figure 2**). During the aerial count of 28 May 1993, 195 flightless Greylag Geese were found on the northern coast of Saltholm, with smaller numbers on the west coast, some of which could fly. On 28 June 1993, 133 were also recorded at the north end of the island (although some of these may have been flying again by this stage) with very large numbers of flying geese on the west coast at this time. Generally, however, the vast majority of flightless moulting birds were confined to the south and southeastern corner of the island. After the flightless period, geese dispersed to Swedish coasts (**Figure 2**) and very few remained on Saltholm.

Ground counts

In 1993, fieldwork commenced after the main arrival period of the geese on Saltholm. Six counts exceeding 6,300 were made during the period 8–16 June, with a maximum of 6,700 on 15 June (**Figure 3**). Numbers declined progressively after that to 722 by 30 June. In 1994, fieldwork was planned to document the arrival phase, and ground counts showed a rapid increase in numbers after 30 May (**Figure 3**). At peak, 7,930 were counted on 7 June in the southeastern corner alone. In 1994, as in 1993, a few geese moulted away from southern and southeastern coasts, most notably *c.*300 on the west coast and *c.*200 on the north end of the island. There was more dispersal away from the immediate area of the observation hide in 1994 compared with 1993, with geese moving along the southern coast out of view of the tower hide. For this reason, many June counts failed to record numbers located earlier in the month. Full census of the entire coastline on 19 June located 9,140 geese, suggesting *c.*8,000 geese moulted in the southeastern corner of the island, with a total of just over 9,000 geese present in all at peak period.

Post-moult, Greylag Geese were relatively slow to disperse from Saltholm in 1994. Numbers on the adjacent Swedish coast at Foteviken did not peak until the last week of August, although numbers increased from mid-July onwards (**Figure 4**). The same was true of the Western Lakes area of southwest Scania where numbers increased to a brief peak in early August (**Figure 4**). Amongst the Eastern Lakes, Greylag numbers increased by 1,000 birds in early July, but a dramatic influx of 3,000 occurred in early August (**Figure 4**).

Activity budgets

During the settlement period prior to moult geese fed for a substantial part of

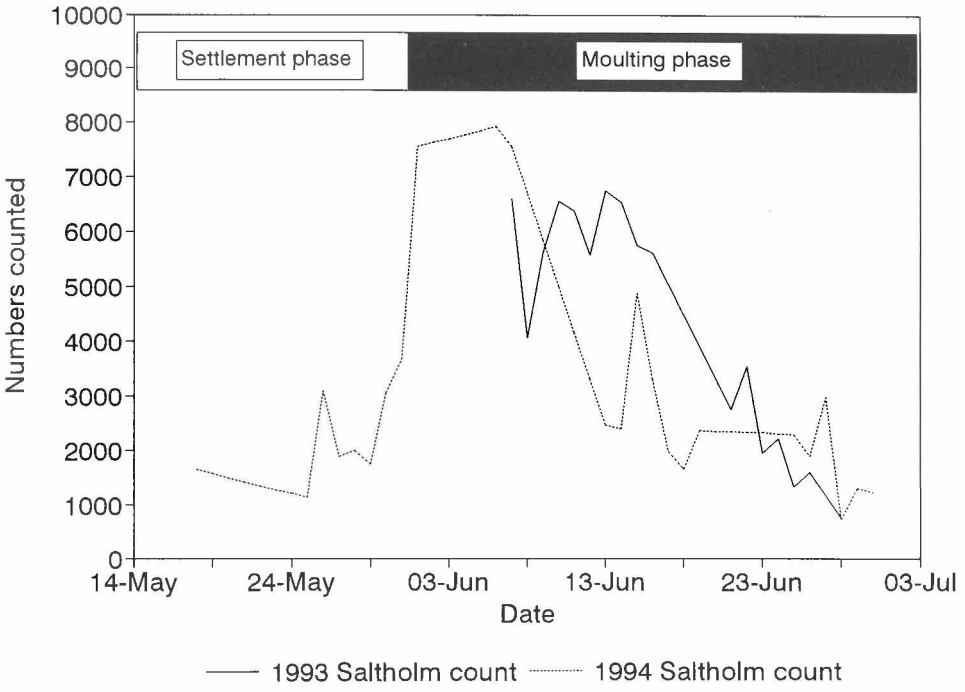

Figure 3. Ground count totals of moulting Greylag Geese in southeastern Saltholm 1993 and 1994.

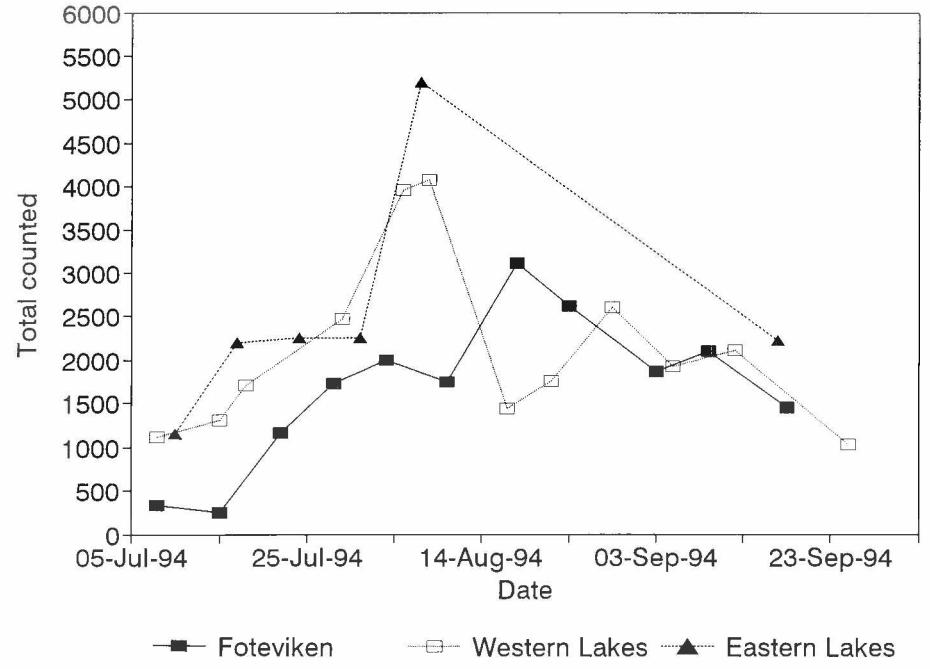

Figure 4. Post-moult ground counts of Greylag Geese from areas of southwest Scania, Sweden during 1994. Counts come from Foteviken, Western and Eastern Lakes areas shown in **Figure 2** and represent count totals from the survey of the same groups of lakes at each time interval.

the daylight hours (**Figure 5**). By late May, less than 10% of the period between 09.00 and 15.00 was spent feeding, the majority fed during 18.00–05.00. At the peak moult stage, the geese fed exclusively by night when they came ashore from their offshore daytime roosting areas (**Figures 5** & **6**). In both study years, there were significant differences between the

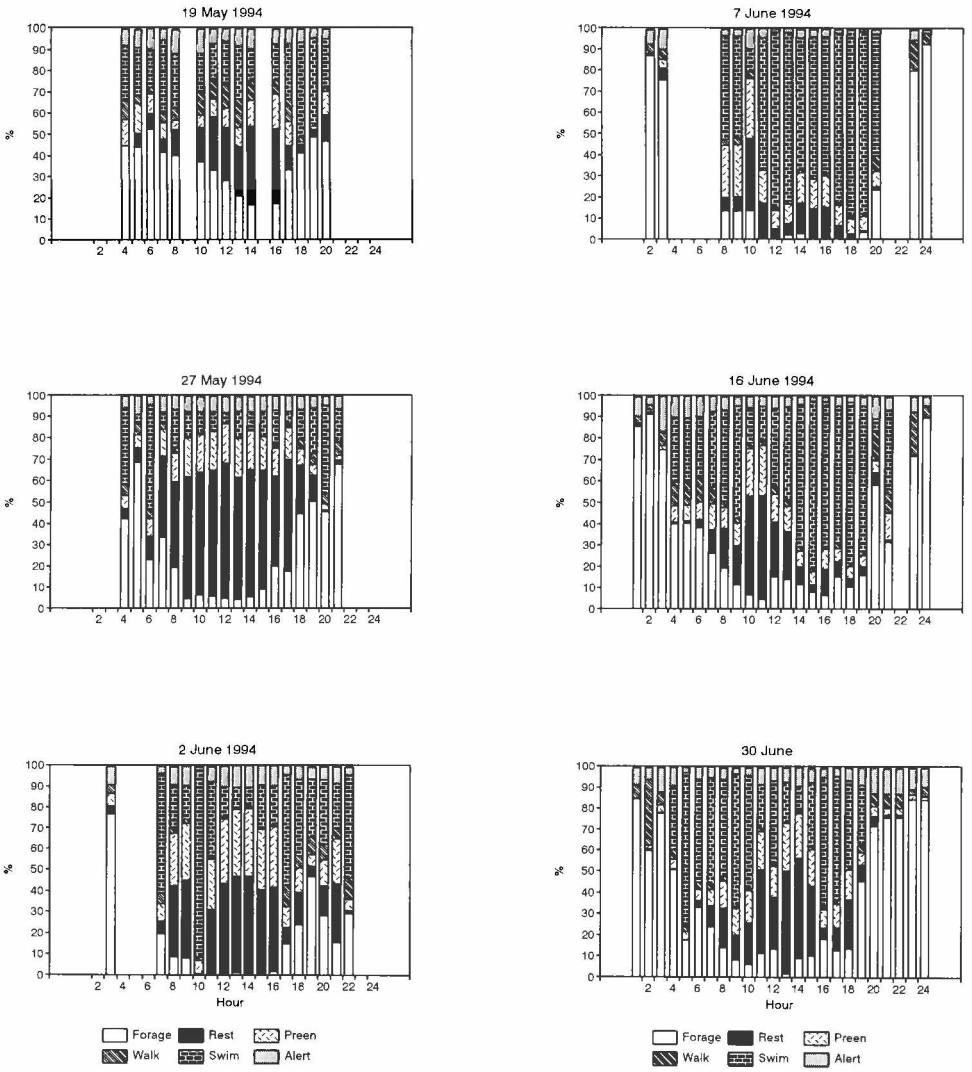

Figure 5. Activity budget data from six periods during the moult of Greylag Geese on Saltholm, May and June 1994.

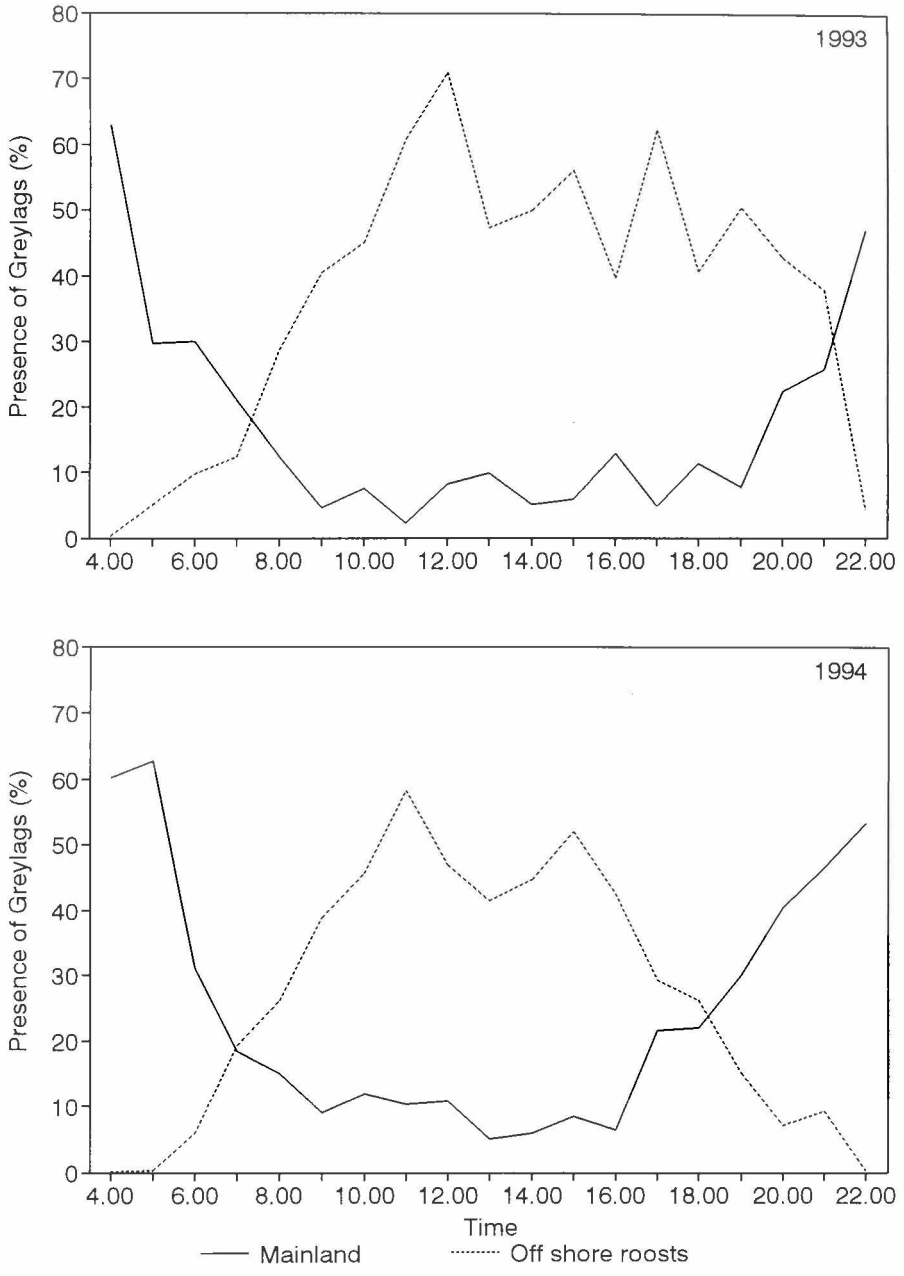

Figure 6. Percentage of Greylag Geese distributed on land and on off shore roosts throughout the daylight period in 1993 (upper) and 1994 (lower).

percentages of Greylag Geese using the land during the sunrise and sunset hours (04.00–07.00 and 19.00–22.00 compared with the daylight hours (ANOVA of arc sine transformed data from 1993, $F_{18,57}$=3.20, P<0.001, and from 1994, $F_{18,115}$=7.71, P<0.001, Duncan's Multiple Range test P> 0.05) and

Table 2. Summary of sites of capture of individually marked Greylag Geese reported on Saltholm during the moult period 1993 and 1994. Data relating to neck-collared birds from L. Nilsson and the Nordic Greylag Goose Working Group. Data relating to leg-ringed birds from N.O. Preuss and the Zoological Museum Copenhagen.

Site of capture	Country	Latitude/Longitude	1993 only	1994 only	both
Neck collars					
Stawno, Golica	Poland	51°33'N, 17°23'E	1	0	0
Risø, Zealand	Denmark	55°42'N, 12°06'E	0	0	2
Rone Ytterh, Gotland	Sweden	57°08'N, 18°30'E	1	0	1
Klosterviken, Scania	Sweden	55°30'N, 13°20'E	5	5	2
Fjällafotasjön, Scania	Sweden	55°31'N, 13°18'E	5	1	1
Yddingen, Scania	Sweden	55°33'N, 13°16'E	9	18	3
Börringesjön, Scania	Sweden	55°33'N, 13°16'E	1	3	3
Leg rings					
Utterslev Mose, Zealand	Denmark	55°43'N, 12°31'E	10	23	1

between those using the off shore roosts during sunrise and sunset compared with the daylight hours (ANOVA of arc sine transformed data from 1993, $F_{18,57}=2.90$, $P<0.001$, and from 1994, $F_{18,115}=5.77$, $P<0.001$, Duncan's Multiple Range test $P> 0.05$).

Origins of moulting birds

In all, 161 resightings of 54 different individual marked geese were made during 1993 and 189 resightings of 66 geese during 1994. In both years, the majority bore blue plastic neck collars used by the Nordic Greylag Goose Working Group in investigations in Sweden (mostly birds summering in southwest Scania) and, to a lesser extent, Denmark (**Table 2**). Two birds marked in Spain on the wintering grounds were also seen in 1993. Combinations of coloured leg rings on birds marked on Zealand in Denmark were also present (**Table 2**).

Age and status of marked individuals

Twenty of the marked birds moulting at Saltholm in 1993 were of known age, as were 28 in 1994. Of these, the majority were one- or two-year old birds (**Figure 7**). First-year birds were more frequent during the early stages of moult than expected by chance in 1994 when observer cover enabled such analysis ($\chi^2_5=16.5$, $P<0.01$), second years and older birds showed no significant seasonal differences.

Detailed life-histories available through the Nordic Greylag Goose Working Group enable patterns of migration amongst Saltholm moulting birds to be presented. In particular, of the geese originating in Scania moulting on Saltholm in 1993 and 1994, approximately 20% of the marked non-breeding element of the population were recorded during the moult on Saltholm (**Table 3**).

Progression of moult and changes in body condition

Mean daily moult scores from observations in 1993 and 1994 showed similar patterns in both years (**Figure 8**). Feather loss was rapid in the last few days of May and early June. API scores declined in both seasons (**Figure 9**).

Discussion

All northern goose species shed and replace their flight feathers simultaneously during the post breeding season, severely restricting dispersal for a period of three to four weeks (Johnsgard 1978, Hohman *et al.* 1992). During this period, differential vulnerability to predation and restricted movement require that moulting sites satisfy a number of criteria to ensure the successful completion of the moult process. These include a sustainable food supply (Rutschke 1987) and a mechanism for the avoidance of predation. For this reason, northern geese often undertake specific moult migrations far from regular summering areas to complete this part of the life cycle (Salomonsen 1968, Hohman *et al.* 1992). The island of Saltholm satisfies both criteria, since it supports abundant managed

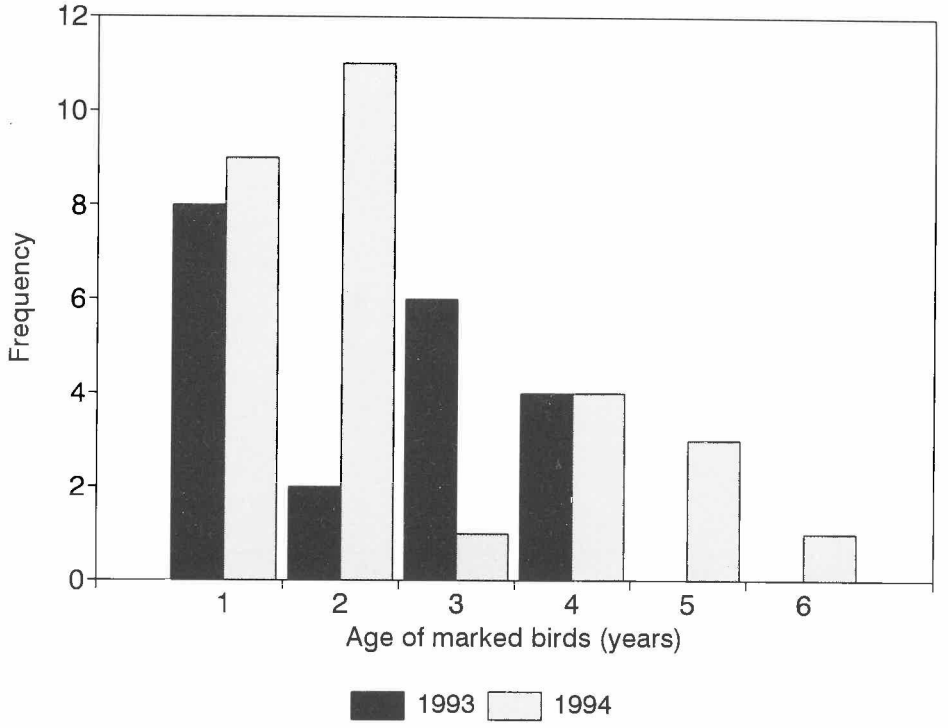

Figure 7. Age frequency distributions of marked Greylag Geese captured in Scania and subsequently moulting on Saltholm during 1993 and 1994.

Table 3. Moulting areas in 1994 for different categories of Greylag Geese marked in Scania.

Category	seen in Scania in spring *n*	moulting in Scania *n*	moulting on Saltholm *n*
SEEN IN SCANIA IN SPRING			
1. **Former breeders**			
Known to have lost brood with young	4	4	0
Not seen with young:			
checked for small young	27	2	2
not checked for small young	20	0	0
Breeding result unknown (no fledged young)	11	0	0
Sub-total	62	6	6
2. **Non-breeder (age)**			
6 years	2	0	0
5 years	7	0	0
4 years	17	2	2
3 years	13	0	0
2 years	27	2	9
1 year	39	11	8
Sub-total	105	15	20
NOT SEEN IN SCANIA IN SPRING			
1. **Former breeders**		**0**	**3**
2. **Non-breeders (age)**			
5 years		0	2
4 years		0	2
3 years		0	0
2 years		0	2
1 year		0	1
Sub-total		0	7

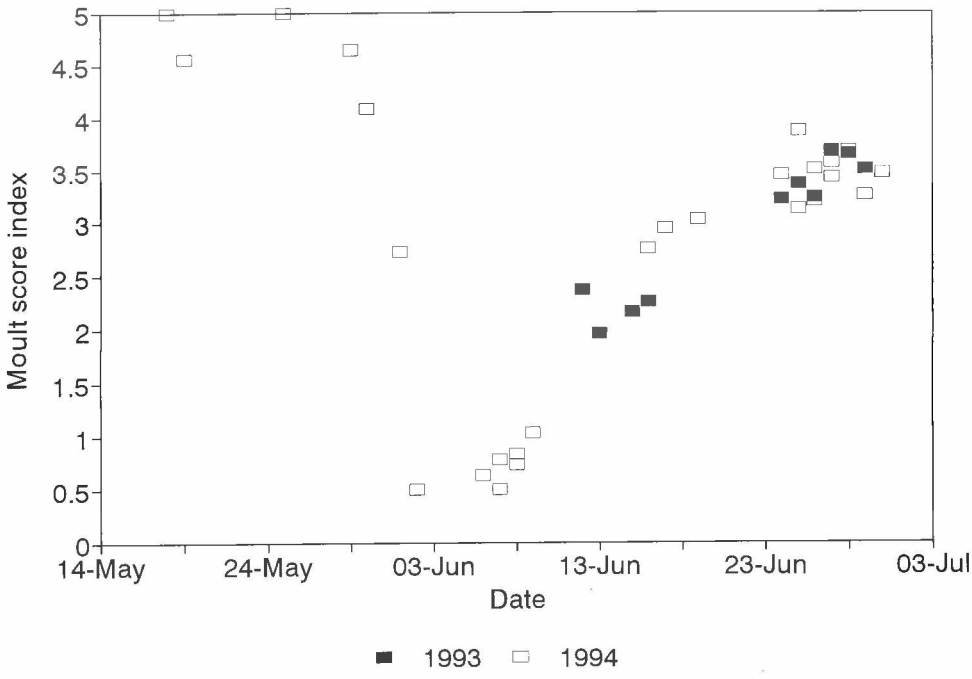

Figure 8. Mean daily moult score data (an index of feather regrowth) from Greylag Geese on Saltholm from 1993 and 1994.

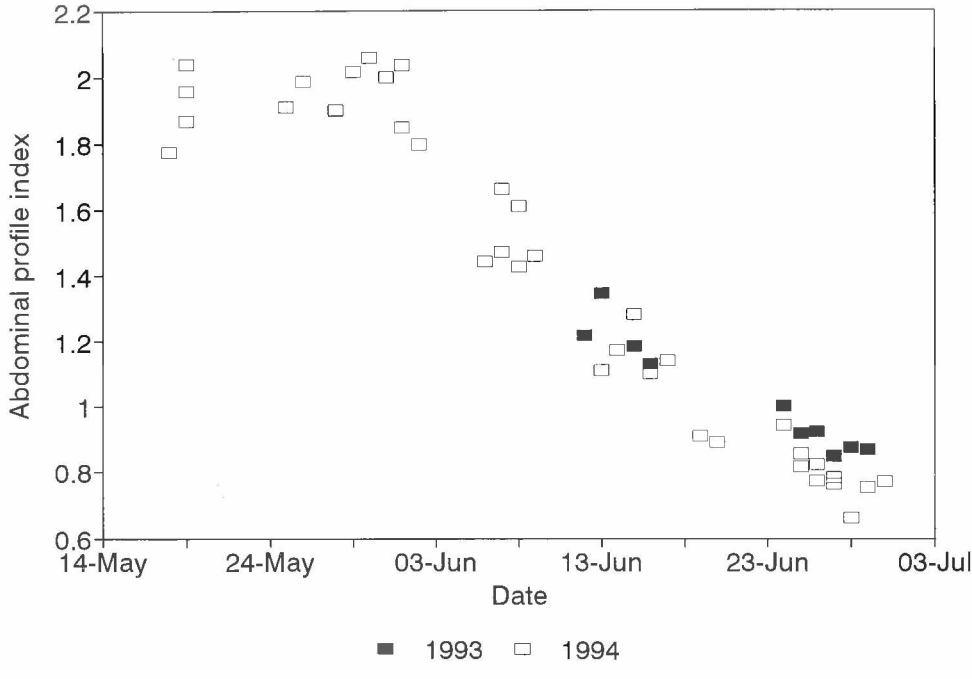

Figure 9. Mean daily abdominal profile index score data (an index of body condition) from Greylag Geese on Saltholm from 1993 and 1994.

grasslands, including protein-rich *Puccinellia maritima*-dominated salt marshes selected by the geese, and the island lacks terrestrial predators (at least in the last seven years, N. Adamsen pers. comm.) and has very low levels of human activity. A full analysis of the feeding ecology of the geese and the available food resource will form the basis of further analysis.

Greylags moulting on Saltholm appear to derive mainly from adjacent areas of Sweden and Denmark, both populations which have shown an increase in numbers in recent years (Nilsson & Persson 1992, 1993, Jørgensen *et al.* 1994). The colonisation of a new moulting site such as Saltholm is likely to result from increasing intra-specific competition for safe moulting sites within the existing range of an expanding population. This may particularly be the case for the non-breeding element of the population, since it is well known that family units are dominant in agonistic interactions over all other ranks of geese, at least on the wintering grounds (Boyd 1953, Black & Owen 1989). There is some evidence that parent geese with families displace non-breeding birds from potential moulting areas in the Greenland White-fronted Goose *Anser albifrons flavirostris* (Madsen 1981). Hence, increasing population size is likely to cause greater pressure on post-breeding feeding resources, exploited both by moulting non-breeders and by family groups for brood rearing. Such a situation is likely to result in the displacement of non-breeders to more remote moulting areas where such competitive interactions may be avoided. The expansion in the breeding numbers of Swedish and Danish Greylag populations in adjacent areas could certainly be responsible for such displacement, and the presence of a proportion of sub-adult functional non-breeding geese (i.e. less than three years old) amongst the marked population moulting at Saltholm would suggest that it is the non-breeding element of the population which is moulting there. Analysis of 1993 resighting data showed that a higher proportion of former breeders went to Flevoland in The Netherlands to moult than to Saltholm, in contrast to the ratios amongst young non-breeders (Nilsson unpubl. data). At the time of writing, there are no data available from The Netherlands to confirm this pattern in 1994. Generally, younger birds arrived and moulted earlier than older geese.

Despite the very recent establishment of the island as a moulting area for Greylags, the results from two years of survey confirm Saltholm as the second most important Greylag Goose moulting site in western Europe, with over 9,100 present at maximum. In addition, observations of a few geese arriving in late June to commence moult at the site suggests that the total numbers throughout the moult were considerably greater. It seems likely that the presence of an extensive area of grazed grassland in close proximity to safe roosting areas with very restricted human access and a lack of terrestrial predators (Lebret & Timmermann 1968, Follestad *et al.* 1988, Zijlstra *et al.* 1991) offers suitable conditions for moult which have been exploited by an increasing number of individuals in recent years. Such a rapid expansion in moulting numbers has also been recorded at Oostvaardersplassen in The Netherlands where numbers increased exponentially from a few thousands in the early 1970s to over 60,000 currently.

Based on resightings and count data, Greylags dispersed to Scania after the completion of the moult, but there was something of a lag between the completion of the moult on Saltholm, the departure from the island and the build-up of geese at monitored resorts in Sweden. Since it is not feasible to monitor all suitable goose sites in Scania, there remains the possibility that large numbers of geese went unrecorded in central Scania at sites not covered by observers. Part of the time lag might be due to the distributional pattern of geese in southwest Scania, since in early July, goose flocks break up into several smaller flocks throughout different parts of the area, making accurate total counts in the lake area hard to obtain. These smaller groups gradually gather into one or two large flocks in the lake area and into the flocks at Foteviken, a

late summer coastal feeding area in Scania (Nilsson & Persson 1992). Several marked individuals seen on Saltholm returned initially to the lake area (their natal sites) before going to Foteviken; such movements have been reported amongst Greylags from elsewhere in their range (Rutschke 1982).

The lack of birds on Saltholm (based on aerial counts) implies they have dispersed away from the island immediately after the moult. Although the counts did not immediately pick up the movement back to Scania, the dispersed nature of the geese at this time makes accurate total counts difficult to derive. Wherever the geese do disperse to, it suggests that the food resource in the southeastern corner of the island (where the vast majority of the geese remained during the course of the moult) was at least beginning to be depleted and offered less profitable foraging possibilities than exist elsewhere by the end of the moulting period.

Resightings of birds occurred up to 40 days apart, although it was considered from regression of wing feather growth on date, that individual geese were actually flightless for only three to four weeks, suggesting perhaps a protracted settlement period on the island before commencement of moult. Many individual geese were seen only once, and it would appear that at least some of the leg-ringed Greylags from Utterslev Mose on Zealand seen on Saltholm in May returned to Zealand subsequently and may therefore not have moulted on Saltholm.

The phenology and progression of moult showed little difference between years. Numbers of Greylags on Saltholm increased through May, and rapidly so after 30 May. Maximum numbers occurred in June but declined towards the end of the month as birds regained the powers of flight and left the island. Only small numbers remained by mid-July. Birds appeared to lose condition based on "mean" population scores of abdominal profile shape and on changes in individuals resighted more than once. Such a loss of weight has been reported for moulting Greylags in The Netherlands where a continuous decrease in the quantity and quality of the available food stock as a result of goose exploitation was considered responsible (Loonen *et al.* 1991). The population mean score was lower in 1994 than 1993 which may suggest food resources imposed a greater loss of condition than in the previous season. However, the detailed analysis of the changes in food resource quality and quantity available to the geese during the course of the moult period is the subject of on-going study.

The data used for this study was collected as part of the base line investigations carried out in connection with the establishment of a fixed road/rail link between Denmark and Sweden. The study was funded by Øresundskonsortiet A/S. The Danish Forest and Nature Agency and the landowners of Saltholm are thanked for permission to work in the study area. We are extremely grateful to the warden Niels Adamsen for practical help and advice, and to Henning Noer, Jesper Madsen and Malcolm Ogilvie for valuable comments on the manuscript. Maarten Loonen and N.O. Preuss kindly gave advice and information on ring readings, and we thank all those enthusiasts who are good enough to report sightings of individually marked geese to enable the compilation of detailed life histories.

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