Inland and saltmarsh feeding of wintering Brent Geese in Essex

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Introduction

The increasing numbers of Dark-bellied Brent Geese *Branta bernicla bernicla* wintering in Britain has led to changes in their feeding habits (St. Joseph 1979b) and periodic damage to agricultural crops. The critical time seems to be from mid-winter to early spring as the geese are then widely dispersed around the east and south coasts, and their intertidal food plants have been heavily exploited. In general, farmers consider the presence of geese on winter cereal crops and young grass leys to be unacceptable, whereas geese feeding on permanent pasture and saltmarsh grassland are not a cause for concern. This study was intended to assess the extent to which in 1979 Brent Geese in one estuary used farmland compared with saltmarsh.

Methods

The study was carried out between January and March 1979 at Hamford Water, an inlet in the Essex coast. The farming is exclusively arable on the north side of the estuary, whilst in the south there are large areas of permanent pasture. Areas of saltmarsh dissected by creeks occur between the main channels, and a particularly large area of saltmarsh is present in the northern part of the water. A seawall protects reclaimed farmland from spring tides.

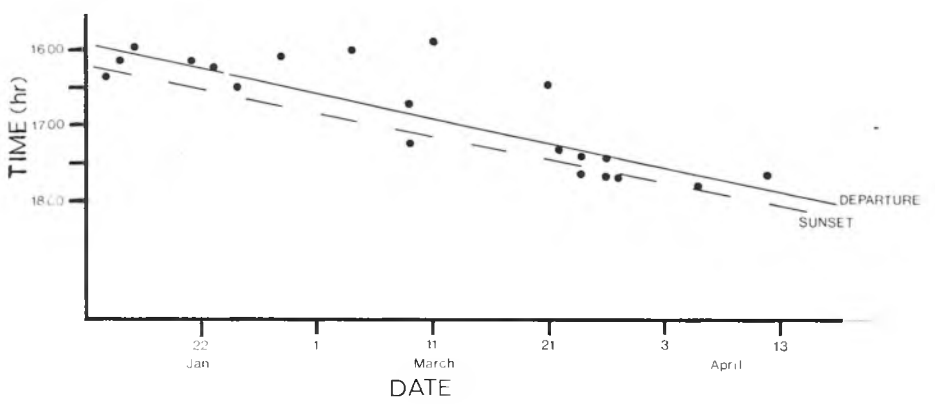
During the study cereal growth was delayed, and so geese rarely visited arable fields. Inland feeding was thus restricted to areas of permanent pasture, and observations were made there as well as on the saltings.

Regular censuses were made of the numbers and distribution of birds, and some counts were repeated at different times on the same day. The main effort was concentrated on watching a particular flock for many hours. The duration of all flock movements during the observation periods was recorded, as was the site at which the flock landed. Observations were continued at the new site whenever possible. Timed observation of individual geese in the flock provided information to compare alertness in the two habitats.

Results

The length of the feeding day was estimated from observations of flights between inland feeding areas and the roosts. Evening flight time is closely related to the changing time of sunset (Figure 1). However, the time of arrival on farmland in the mornings was not apparently related to date, probably because of the confusing influence of the tide and the staggered arrival inland of skeins of geese.

Figure 1. Time of evening flight to roost. Regression of time of flight on date gives $y = 0{\cdot}03 + 15{\cdot}94$ ($p<0{\cdot}01$).



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From this information, the time spent on inland feeding grounds by the geese during the study period was found to have a mean of 8·82 hours per day. This does not take into consideration any night time feeding, which was restricted to saltmarsh and was only apparent during high tide on moonlit nights. It is therefore unlikely to contribute a large proportion of the daily feeding time.

The actual time spent on farmland each day was less than the calculated time because of disturbance. The comparison of whether flocks landed on other farmland or on saltmarsh following a major disturbance has been corrected for varying levels of disturbance by representing the number of flights made across the seawall as a proportion of the total number of major movements that occurred (Figure 2).

It is apparent that proportionately more flights are made to the saltmarsh in the period before high tide, and Table 1 shows that the difference is statistically significant ($p < 0{\cdot}001$). A return to grassland would seem to be indicated in the hour following high tide (Figure 2) although this was not found to be statistically significant. Observations of birds feeding on the saltmarsh were not as complete as those of birds feeding inland, which may account for the lack of significance.

These results show that disturbed flocks are more likely to settle on the saltmarsh around high tide than at other times. An independent test of whether movements to saltmarsh were occurring at high tide was made by censusing inland feeding birds twice in the same day, once within one hour of high tide and once when the tide was half down, or lower. The results of these counts are summarized in Table 2, and there were less birds inland at high tide ($p < 0{\cdot}001$), which is not attributable to a difference in numbers between morning and afternoon ($p > 0{\cdot}1$). It is important to note that all the geese did not leave farmland at high tide. This emphasizes the effect of disturbance in initiating the movement, and the fact that the geese will remain inland if they are not disturbed over high tide.

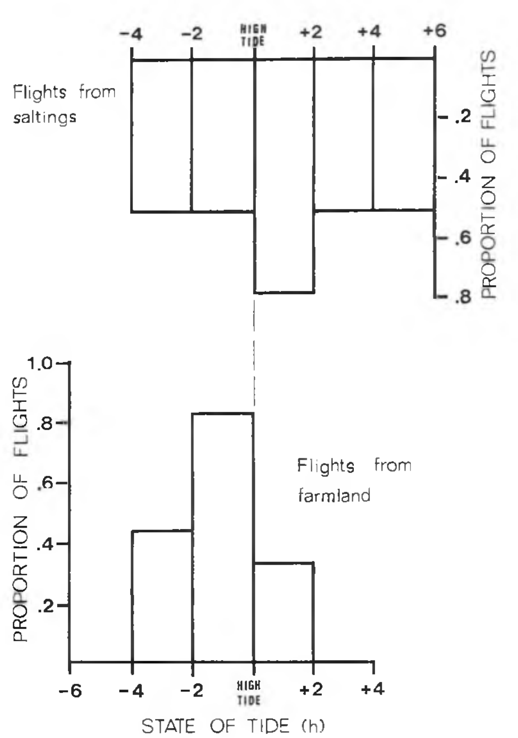

Figure 2. Movements of goose flocks in relation to tide. Histograms show the numbers of flights that resulted in a change of habitat (e.g. from farmland to saltings) as a proportion of the total number of flights made in that hour.

In order to estimate the time spent feeding on saltmarsh, 12 visits from farmland to saltmarsh and back were timed. These averaged 1·45 hours for trips arriving on saltmarsh within 2 hours before high tide, and 0·57 hours at other times, which are significantly different ($p < 0·05$). This again illustrates a change in the preference for feeding on saltmarsh according to the tide.

The mean daily time spent feeding on the saltings was estimated using the data on length of stay and frequency of disturbance, and was found to be 1·58 h/day. Using this value the proportion of the day that the southern flocks spent on the saltings was calculated, which was 13% of the total feeding time (measured by goose-hours). Whilst saltmarsh feeding was of some value to the geese it was obviously not as important as inland feeding.

The geese in the north of Hamford Water had no pasture to feed on, and were thus restricted entirely to saltmarsh. The best estimates of goose numbers in that area and on the farmland of the south have been used to compare densities of geese in the two areas. A total of 500 geese was estimated to have grazed over an area of 184 ha of saltmarsh, whereas 2,290 geese grazed 228 ha of pasture, which gives densities of 2·7 and 10·0 geese/ha respectively.

The results presented so far show that the inland pasture supported a higher density of geese than the saltmarsh, and that given a choice of the two habitats a flock spent almost 90% of its feeding time on inland pasture. However, for a short period around high tide the utility of saltmarsh apparently increased, and disturbed flocks landed there to feed more than at other times.

The selection of feeding area by geese is likely to be such as to maximize the net gain of nutrients through the day, and as a result will be dependent both on the availability and quality of the food and also on the energy expenditure incurred feeding there. The major cause of energy expenditure is likely to be disturbance that results in flight (Wells 1981). Owen (1972b) showed that disturbance was the main factor influencing goose-usage of the Slimbridge refuge, whilst Owens (1977) reported that Brent Geese in Essex avoided heavily disturbed places until forced to utilize them when food in other areas became depleted.

Disturbance was assessed by recording the number and duration of flights made by flocks during periods of continuous observation. When feeding, geese lift their heads to get a good all round view and are then said to be alert. An index of the level of alertness was measured for different age classes of birds in both habitats. In this study the length of the inter-alert interval was measured, defined as the time from when the goose lowered its head below the level of its back to when it next raised it to or above that level. Juvenile birds were distinguished from adults, and on farmland birds at the periphery of the flock (at or within 2 birds of the flock edge) were also recorded separately from others in the flock, which were termed central birds.

The data for inter-alert interval were

Table 1. Effect of tide on flights to and from farmland (Using Fischer's Exact Test)

Origin of flights	Destination of flights	
Farmland	Other farmland	Saltmarsh
In the 4hr before high-tide	6	9
Other times	18	1
$p<0·001$	Total flights = 34	
Saltmarsh	Other saltmarsh	Farmland
In the 2 hr after high-tide	2	7
Other times	5	4
$p>0·05$	Total flights = 18	

Table 2. Mean numbers inland, counted twice per day. Mann-Whitney U-test for small samples.

	High tide versus low tide		Morning versus afternoon	
	High tide	Not high tide	Morning	Afternoon
Mean	544	2,373	1,385	1,531
	$n=4$, $U=1$	$p=0·029$	$n=4$, $U=6·5$	$p<0·1$

highly skewed and were analysed using the median test. Table 3 lists the median values. Juveniles had shorter inter-alert intervals than adults on farmland ($p < 0{\cdot}05$) with a similar trend on saltmarsh ($p < 0{\cdot}075$), whilst on farmland the values for peripheral birds were shorter than for central birds ($p < 0{\cdot}05$). Comparing the same age classes on saltmarsh and on farmland, however, there was no significant difference in time between head-ups.

Direct measurement of disturbance can be made from the number of times per hour that a flock is disturbed and the amount of time spent flying as a result. Disturbance levels on the saltmarsh may be biased because of the occasional testing of explosives at a nearby factory, and no correction can be made for this. Disturbance flights were made more frequently on the saltmarsh, but they lasted for a shorter time than those on farmland (Mann Whitney U-test: frequency $p < 0{\cdot}05$; duration $p < 0{\cdot}01$). Combining the mean values for frequency and length gives 93 seconds/hour as the mean flying time on saltmarsh and 98 seconds/hour as the mean for farmland. This is similar to the total flying time of 2·8% of feeding time (101 sec/hr) measured by Owens (1977) for Brent Geese in Essex, and the small difference between farmland and saltmarsh is in agreement with the similar levels of alertness found in each place.

Discussion

Since the first reports of large numbers of Brent Geese feeding inland in 1963 there has been a progressive increase in the use of farmland by the geese, and St. Joseph (1979b) recorded 61% of the East Coast birds feeding inland in January 1977, increasing to 92% in March.

During this study the majority of the birds—those in the south of Hamford Water—were spending about 87% of their daily feeding time on inland feeding areas from January onwards, whilst a minority were feeding exclusively on saltmarsh. This interpretation is borne out by colour ring sightings (St. Joseph 1979a, and pers. com.) which shows that individual birds have very restricted ranges within the study area, and thus little mixing between flocks occurs. It would seem that in certain areas many Brent Geese are now almost totally reliant on inland feeding during the second half of the winter.

The increased use of saltmarsh by inland feeding birds at high tide is unlikely to be related to any effect of the tide on food availability such as Charman (1975) found for Brent Geese feeding on intertidal *Enteromorpha*, since the saltmarsh plants are above the level of all but spring tides and are rarely inundated. One possible reason for the increased appeal of saltmarsh at high tide is that the presence of water in the creeks may lessen the risk of predation as the birds are then foraging on islands. However, the birds were no less vigilant at high tide compared with other times. Inter-alert intervals of adults and juveniles combined were in fact significantly shorter at high tide (combined probabilities of independent test (see Sokal & Rohlf 1969), $p < 0{\cdot}05$), and there would seem to be no increase in the security of saltmarsh at high tide. An alternative explanation is that movement between islands is easier as the

Table 3. Alertness of geese according to position in flock, age, and habitat. Classes of birds are shown together with their median inter-alert periods and the probability of difference between medians

		Median (sec)		Median (sec)	*P*
A. Juveniles vs Adults					
Inland central:	Juvenile	10·3	Adult	7·6	<0·05
Inland peripheral:	Juvenile	7·7	Adult	6·3	<0·05
Saltings:	Juvenile	8·1	Adult	6·1	N.S.(<0·075)
B. Central vs Peripheral (Inland)					
Adult:	Central	7·6	Peripheral	6·3	<0·05
Juvenile:	Central	10·3	Peripheral	7·7	<0·05
C. Saltings vs Farmland					
Adult:	Saltings	6·1	Grassland (central)	7·6	N.S.
	same data as above		Grassland (peripheral)	6·3	N.S.
Juvenile:	Saltings	8·1	Grassland (central)	10·3	N.S.

birds can swim across creeks instead of having to fly, and foraging efficiency is thus increased.

The alertness of geese as assessed here agrees with previous studies of flocking birds. Peripheral birds have been found to be more alert than central ones (Lazarus 1978), attributable to a greater risk of predation (Hamilton 1971). Owen (1972a) has suggested that with geese the abundance of parental adults at the flock edge also produces higher alertness there. In the same paper he reported lower alertness of juvenile birds, as found in this study and with Barnacle Geese *Branta leucopsis* (Wells 1981).

Highly alert geese may discourage others from landing (Inglis & Isaacson 1978), and Owen (1972a) found that flocks differing in alertness were responding to variation in the amount of disturbance. The similarity in alertness of Brent Geese on inland and saltmarsh sites suggests that they did not detect any differences in disturbance levels, and so this did not affect their decision to feed inland.

The amount of time geese spent flying during this study is very similar to the mean time given by Owens (1977). In his study a maximum flying time of 6·5% was reported, while a time of 1·1% was calculated for flocks without any disturbance. Energy expenditure of geese with different flight times can be compared using standard values for energy use by birds performing various activities, and are expressed as multiples of the animals' basic metabolic rate (BMR). Flying is reported as requiring energy expenditure of 12 × BMR (Tucker 1969; Lefebvre 1964) whilst normal foraging on dry land requires 1·7 × BMR (Wooley & Owen 1978). Using these values it is possible to calculate energy expenditure for the daylight hours. The undisturbed flocks (1·1% flying) are estimated to utilize 7% of their daytime energy output in flying, whilst the heavily disturbed flocks (6·3% flying) are estimated to utilize 33%. This increase in flying due to disturbance results in an increase in the total daytime energy expenditure of 31%.

The geese observed during this study are estimated to have been expending 15·9% of their daytime energy output flying when on saltmarsh, and 16·4% when on farmland.

These figures illustrate the potential effect of disturbance manipulation on the geese's energy budget. The provision of refuge areas on permanent pasture and saltmarsh combined with intensive scaring over sensitive crops will maximize the benefit to the birds of feeding in the former areas, as in this way they will considerably reduce their energy expenditure. If, in addition, the value of the available feeding in refuge areas is improved then the rate of energy intake will increase, further encouraging the use of these areas. Experiments aimed at improving the quality of food on the saltings by the use of sheep grazing in summer are currently underway (St. Joseph, pers. com.).

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Summary

Brent Geese *Branta bernicla bernicla* wintering in Essex during 1978/79 were studied on saltmarsh and farmland. The majority of the birds spent 87% of their day feeding inland, making trips to saltmarsh only when disturbed. Saltmarsh feeding was most common around high tide, and the density of birds supported on inland pasture was three times that on saltmarsh. Disturbance levels were similar in the two habitats. Estimation of goose energy budgets emphasizes the combined rôles of disturbance-free refuges and scaring over crops for managing geese.

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