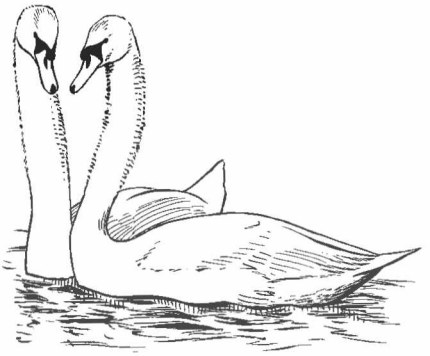
A change of moulting site for Mute Swans *Cygnus olor* in Gloucestershire



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The distribution and activities of moulting Mute Swans were monitored in July and August 1991 at two sites in the Severn Vale, Gloucestershire; the pools of Slimbridge Wildfowl & Wetlands Centre, and Frampton gravel pits some 5 km northeast of Slimbridge. The number of birds moulting at Slimbridge has increased rapidly since 1987, with a corresponding decrease in numbers at Frampton and, by 1992, only two breeding pairs remained to moult at the Frampton site. Differences in activity patterns of moulting swans at the two sites in 1991 indicated the causes underlying this change in distribution. Provision of a concentrated food supply in shallow pools at Slimbridge, together with low levels of disturbance, allowed birds there to spend significantly less time swimming and significantly more time in comfort activities such as preening than those at Frampton. The percentage of time spent feeding was the same at both sites (42%) but the mode of feeding differed significantly, with more grazing and less upending at Slimbridge.

Keywords: Britain, Moult, Feeding, Activity Budget, Mute Swan

Mute Swan *Cygnus olor* is widespread in lowland wetlands in Britain with the highest breeding densities occurring largely in southern and eastern England. The total population in spring 1990 was estimated at 25,748 birds of which 7946 (3973 pairs) were recorded breeding (Delany *et al.* 1990). Some 269 swans were counted in Gloucestershire in spring 1990, of which 108 (54 pairs) were breeding birds. The British population has increased by around 37% since 1983 as a result of a combination of factors. These include a reduction in lead-poisoning following a ban on lead fishing weights in England in 1987, together with a run of three exceptionally mild winters from 1988 to 1990 which reduced winter mortality (Delany *et al.* 1990).

The population of Mute Swans in the area around Slimbridge Wildfowl & Wetlands Centre, Gloucestershire, has also increased markedly during the last fifteen years, in line with increases in neighbouring counties (Slater *et al.* 1990). In spring 1978 five non-breeding birds were counted in the 10 km grid square containing Slimbridge and Frampton (Ogilvie 1981). No non-breeding birds were located in the same grid square in spring 1983 (Ogilvie 1986) but in spring 1990 a total of 109 was counted, placing it amongst the top 30 squares in Britain for non-breeding birds (Delany *et al.* 1990). Mute Swans were initially discouraged from residing in WWT's collection at Slimbridge because of competition with captive birds, both for the provisioned grain and for breeding territories. A reduction in active discouragement in the mid-1980s, coupled with the national increase in the Mute Swan population, has resulted in increasing numbers of birds both at Slimbridge and nearby at Frampton.

Behavioural data collected in this study is used in an attempt to explain changes in the distribution of moulting Mute Swan flocks in the lower Severn Vale in Gloucestershire.

Methods

Twice weekly observations were made of the Mute Swans at Slimbridge and Frampton between 15 July and 29 August 1991. On each visit the number of birds present, their activities and ring numbers were recorded. At Frampton four gravel pits were monitored, although all the non-breeding birds spent the entire period on just one lake. At Slimbridge, the main flock was concentrated on one pen in the collection with small numbers on adjacent pens. Hourly flock counts were conducted

during each visit to a site; once a week a simultaneous count was made at the two sites.

The activity patterns of swans at the two sites were monitored by conducting flock scans of the two main concentrations of swans every 30 minutes. During each scan, the activity of each bird in the flock was recorded. The sampling day was split into two periods, morning (0930-1130 h) and afternoon (1430-1600 h). Activities were placed into six main categories:

1) Feeding - including grazing, surface dabbling, head-under and up-ending.
2) Comfort activities - including preening, washing and scratching.
3) Sleeping.
4) Loafing - birds sitting on land or water, and not engaged in other activities.
5) Movement - including swimming, walking and flying.
6) Social interactions - including aggression and courtship.

Data within each scan were lumped by category and expressed as a percentage of the total flock size.

Detailed records were also maintained on the presence or absence of individual birds, identified by the codes engraved on their plastic leg rings (Ogilvie 1972), at each of the two sites in order to detect any interchange between the flocks, thus identifying the duration of an individual's moulting period.

Results

Swan numbers

In 1978 the maximum count of Mute Swans at Slimbridge was just ten birds, but numbers rose slowly through the early 1980s reaching 20 for the first time in August 1985. Thereafter the increase was more rapid, with maxima of 100 in January 1988 and 196 in November 1989 (**Figure 1**).

Prior to 1987, the highest annual counts at Slimbridge typically occurred during the winter months. Numbers would drop markedly during the summer with some birds dispersing in spring to breed, and the remainder dispersing to moult elsewhere during the months of June to August (Slimbridge monthly refuge reports).

Movements

228 Mute Swans were fitted with individually-marked Darvic leg rings at Slimbridge

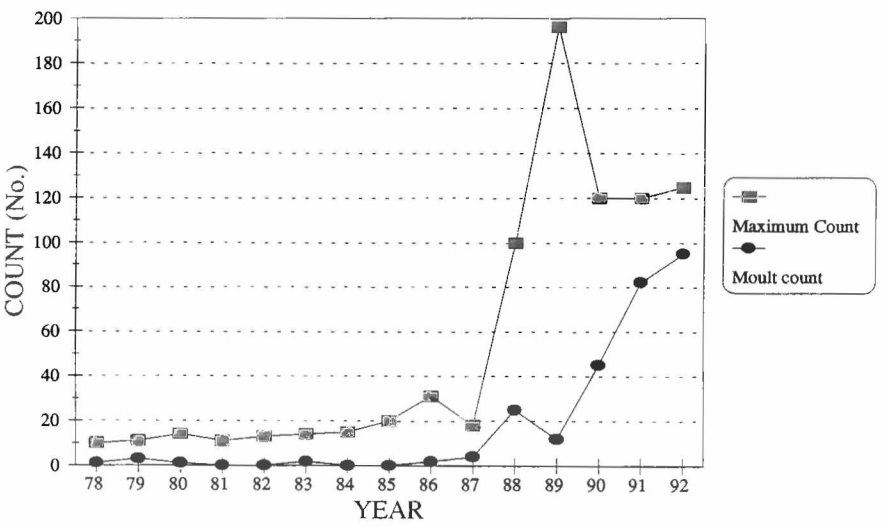

Figure 1. Numbers of Mute Swans at Slimbridge.

Table 1. Re-sightings of individual Mute Swans colour-ringed at Slimbridge between 1988 and 1992 (maximum movement per bird).

Location	Swans *n*	% of total
Slimbridge only	48	21.05
Local sites <10 km	70	30.70
Elsewhere in Gloucestershire	23	10.09
Worcestershire	15	6.58
West Midlands (inc Salop)	6	2.63
Herefordshire	6	2.63
Wales	2	0.88
Lancashire	1	0.44
Avon	6	2.63
Somerset	1	0.44
Dorset	2	0.88
Wiltshire	2	0.88
Not relocated	46	20.17
Total	228	

between spring 1988 and December 1992. Observations of these birds have highlighted movements away from the site (see **Figure 2** and **Table 1**). More than one fifth of the ringed swans were observed subsequently at Slimbridge only, and over half of

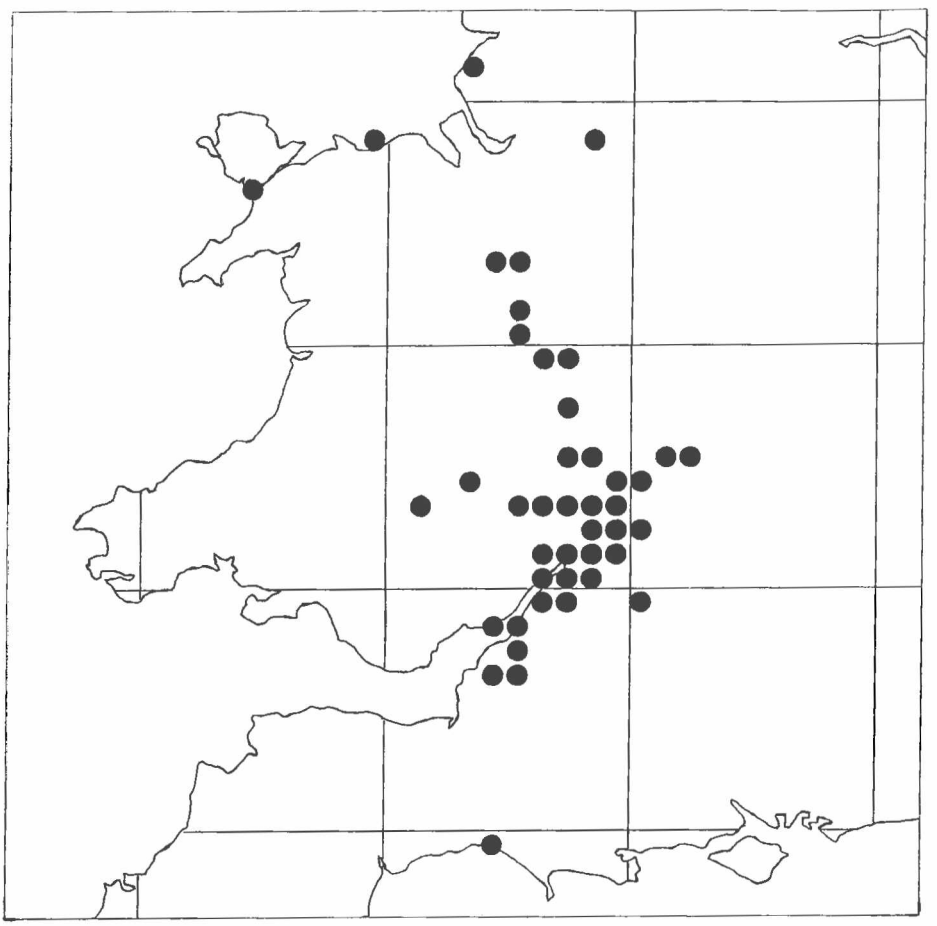

Figure 2. Sightings and recoveries of Slimbridge-ringed Mute Swans (1988-1992).

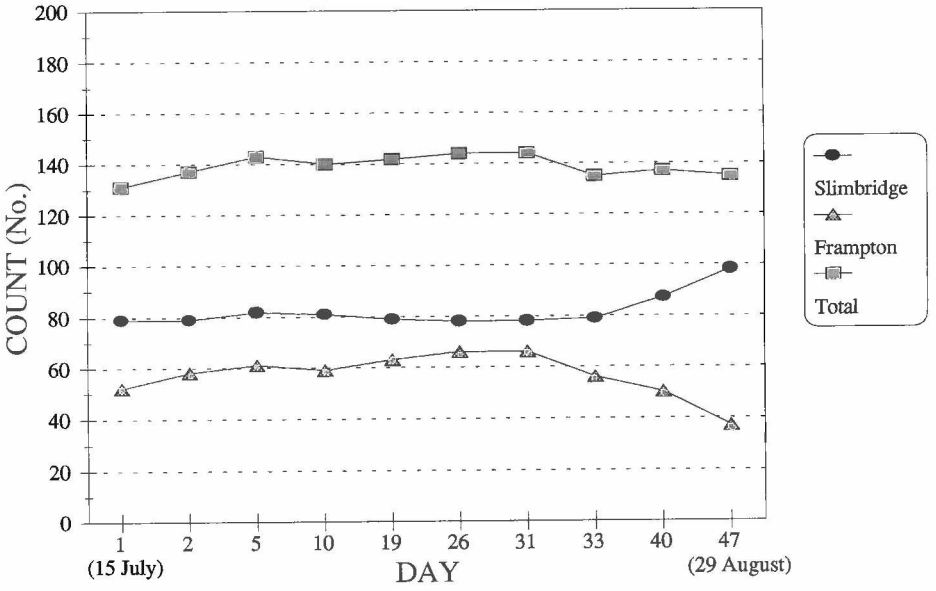

Figure 3. Numbers of Mute Swans at Slimbridge and Frampton; 15 July-29 August, 1991.

the birds were re-sighted only within a radius of 10 km from the site. Less than one fifth (18%) of the birds have been observed in counties other than Gloucestershire. Movement of Slimbridge-ringed birds away from the site was mostly northwards along the Severn and Avon valleys. High ground restricts movement to the west, south and east. South-westerly movements are less impeded by high ground and there were nine records from Avon, Somerset and Dorset (3.9%).

Re-sightings of non-breeding Slimbridge-ringed birds during the summer months in 1988-1992 revealed that their main moulting site was at Frampton gravel pits, a series of largely disused and flooded clay and gravel workings. During the early 1980s, the bulk of the non-breeding birds from Slimbridge moulted at Frampton, with only the occasional breeding pair remaining at Slimbridge (Slimbridge monthly refuge reports - **Figure 1**). The proportion of birds remaining to moult at Slimbridge began to increase rapidly after 1987 and, in 1991, 82 (59.9%) of the 137 birds at the two sites moulted at Slimbridge. In 1992, only two breeding pairs remained at Frampton during the moulting period, the remainder moulted at Slimbridge.

Distribution

Results of the flock counts conducted during the 1991 study period are given in **Figure 3**. The total number of birds recorded at the two sites ranged from 131 on 15 July to 144 on 8 and 13 August. The average count was of 137 birds and numbers remained relatively constant throughout the study period. Slimbridge held the majority of the moulting swans, with 82 birds compared to 55 at Frampton. Numbers at the two sites remained fairly constant until 22 August when they began to drop at Frampton and correspondingly increase at Slimbridge (**Figure 3**). Re-sightings of four birds at Slimbridge, which had been observed in moult at Frampton, during this period, indicated that birds were returning to Slimbridge. Seven birds that had moulted at Slimbridge were observed at Frampton in mid-August. However six of these birds subsequently returned to Slimbridge, including one on the same day,

Table 2a. Comparison of activities of moulting Mute Swans in the months of July and August (Kruskal-Wallis Chi-square comparisons). Percentage of birds engaged in each activity (data from both sites combined), df=1 in all cases).

	July *n*=42		August *n*=57				
Activity	Mean	S.D.	Mean	S.D.	K.W. Chi-sq	*P*	
Feeding	42.21	19.81	42.39	18.08	0.041	0.840	
Comfort	18.67	12.36	17.35	11.26	0.257	0.612	
Loafing	13.26	8.83	23.91	19.36	7.946	0.005	**
Movement	19.76	17.70	10.90	8.66	8.171	0.004	**
Sleeping	5.69	7.05	4.70	6.63	0.365	0.546	
Interaction	0.36	1.53	0.75	2.23	1.655	0.198	
Table 2b. Comparison of feeding modes							
Upending	4.26	7.07	3.09	5.64	0.303	0.582	
Grazing	4.41	13.95	0.91	3.93	2.345	0.126	

Table 3a. Comparison of activities of moulting Mute Swans at Slimbridge and Frampton (Kruskal-Wallis Chi-square comparisons). Percentage of birds engaged in each activity (df=1 in all cases).

	Slimbridge *n*=54		Frampton *n*=45				
Activity	Mean	S.D.	Mean	S.D.	K.W. Chi-sq	*P*	
Feeding	42.89	17.27	41.62	20.53	0.781	0.077	
Comfort	22.30	11.60	12.64	9.51	17.865	0.000	**
Loafing	20.39	14.07	18.20	19.26	2.859	0.091	
Movement	8.52	4.32	22.02	17.51	18.443	0.000	**
Sleeping	4.87	6.21	5.42	7.49	0.137	0.711	
Interaction	0.83	2.29	0.29	1.46	4.286	0.038	*
Table 3b. Comparison of feeding modes							
Upending	0.63	3.08	7.13	7.26	45.106	0.000	**
Grazing	4.39	12.79	0.00	0.00	10.162	0.001	**

indicating some daily interchange between the two sites outside the moulting season.

Activities

A total of 103 flock scans was conducted, 54 at Slimbridge and 49 at Frampton. Feeding was the most common diurnal activity at both sites throughout the moulting period, 42.3% of the swans were recorded feeding during the flock scans. Other major activities were loafing (19.4%), comfort (17.9%), and active movement (mostly swimming, 14.7%). Less frequent activities included sleeping (5.1%) and social interaction (0.6%). The most common mode of feeding was with head and neck submerged; up-ending and grazing were less frequent (3.4% and 2.4% of total observations respectively).

Changes during the moult period

Activity patterns were found to be broadly similar in July and August, with no significant differences in the percentage of birds engaged in the activities of feeding, sleeping, comfort or social interaction between the two months (**Table 2**). The percentage of birds loafing was significantly higher in August than in July, while the percentage of birds engaged in active movement was significantly lower in August than in July.

Comparison between sites

Activity patterns were found to be significantly different at the two sites (**Table 3**). Although the percentage of birds feeding at the two sites did not differ, the mode of feeding differed significantly. Significantly higher percentages of birds were recorded up-ending at Frampton and grazing at Slimbridge. Birds at Slimbridge were

recorded significantly more often engaged in comfort activities, mostly preening, and less often engaged in active movement than at Frampton. In addition the percentage of time engaged in social interactions at Slimbridge was significantly higher than at Frampton. There was no difference in the type of social interaction between the two sites (Comparison of aggressive to non-aggressive interaction, Chi-square test=0.470, $P > 0.4$, df=1).

Ringed birds

Sixty-six (48.2%) of the 137 birds moulting at the two sites bore darvic leg rings. Fifty-four (81.8%) had been ringed at Slimbridge, ten (15.2%) along the Severn and Avon valleys in Worcestershire, one on the River Thames and one in Shropshire.

The proportion of ringed birds moulting at the two sites was not significantly different (Chi-square test=2.47, $P > 0.1$, df=1) but the proportion of non-Slimbridge ringed birds moulting at Frampton was significantly higher than at Slimbridge (Chi-square test=4.13, $P < 0.05$, df=1).

Discussion

The proportion of time that the birds spent feeding in Gloucestershire (42.3%) is higher than in other similar studies, including 36% recorded in winter at Cork Lough, Ireland (Keane & O'Halloran 1992), 30% recorded in winter at Caerlaverock, Scotland (Black & Rees 1984) and 22% recorded throughout the year in an urban area of the Thames valley (Sears 1989). In the latter study, a reduction in feeding activity was noted during the moulting period at an urban site, where bread was the main diet, but there was a peak in feeding activity at a rural site, where birds were feeding predominantly on aquatic vegetation. Van Dijk & Van Eerden (1991) reported that Mute Swans on the Ijsselmeer in the Netherlands lost weight during moult and suggested that food may have been limiting. This may be because the flightless swans are unable to disperse once the food supply has been used. Andersen-Harild (1981) found that Mute Swans in Denmark lost up to 20% of their body mass during moult but added that weights varied according to the quality of food available. Choice of moult-site with respect to habitat quality and food supply is clearly important, since it has been shown that there is strong positive correlation between body weight and start of wing moult (Andersen-Harild 1981, Van Dijk & Van Eerden 1991). Rapid changes in moult-site choice, as demonstrated in the current study, highlight the adaptability of Mute Swans to changes in food supply. Moult was found to have a negligible effect on weights of fully-grown adult Mute Swans in Staffordshire (Bacon & Coleman 1986), but there was a significant weight loss in first-year males, suggesting that food availability might have been limiting for birds that were still growing. The high proportion of time spent feeding in the current study might indicate that the birds were attempting to maximise their food intake during this vulnerable period. The very similar percentages of feeding activity at the two sites is interesting since an elevated level of feeding might have been expected at Slimbridge, where the public is encouraged to feed birds in the collection area with grain. However, grain is rich in protein and the birds may therefore not need to feed so often compared to those feeding mostly on aquatic vegetation assuming it is of lower calorific value (Black & Rees 1984).

There are two possible explanations for the differences in the proportion of time employed in different foraging techniques at the two sites. First, the Frampton birds were feeding predominantly on submerged vegetation which, in deeper areas, required the greater reach of an up-ending swan whereas those at Slimbridge were able to feed predominantly along the shallow edge of pools in the collection, where grain was distributed by WWT staff and by the general public. Secondly the absence of predators and disturbance within the fox-proof enclosures at Slimbridge allowed moulting birds to graze safely on the grass swards adjacent to their moulting pools. These differences are important since up-ending may be less efficient than other feeding modes such as grazing, depending on the availability of vegetation at different depths (Spray & Bayes 1992). Similarly, differences in the proportion of time spent swimming at the two sites may be due to the more dispersed nature of food at Frampton and to differences in disturbance levels. The higher proportion of time spent swimming at Frampton would in turn allow

less time for comfort activities such as preening. At Slimbridge, highly concentrated provision of grain and an absence of disturbance might reduce time spent in energetically-expensive swimming activities, which in turn would allow more time for comfort activities, particularly preening. Preening is important during moult since the grooming and plucking of feathers facilitates renewal, and it was the most frequent activity amongst moulting Mute Swans on the Upper Thames (Sears 1989). The higher proportion of time spent in social activities (mostly aggressive interactions) at Slimbridge may have resulted from the higher density of birds at the site, since it has been shown that aggressive encounters in the Bewick's Swan *Cygnus columbianus bewickii* tend to be more frequent when birds are at high densities (Scott 1978).

The authors wish to thank Dr E.C. Rees for making constructive comments on early drafts of this paper and Carl Mitchell for providing ringing and resighting information. Simon Delany, Carl Mitchell and Rosie Ounsted also added useful comments to the manuscript.

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