Feeding activities of Bewick's Swans *Cygnus columbianus bewickii* at a migratory site in the Estonian SSR.

EILEEN C. REES and JONATHAN M. BOWLER

Observations were made of up to 928 Bewick's and 63 Whooper Swans staging at Matsalu Bay, Estonia over a 10 day period from 24 April to 3 May 1988. Bewick's Swans out-numbered the Whooper Swans by a ratio of 33:1 during the study period, which differed from the 3:1 Bewick's to Whooper Swan ratio reported in the immediately preceding years. The maximum count of 1800 migratory swans recorded on the Matsalu State Nature Reserve in spring 1988 was also low, however, and the missing birds were thought to be mainly Whooper Swans.

Flock scans of swans visible from Haeska, on the north shore of Matsalu Bay, found that on average 59.0% of birds were feeding and 24.5% were sleeping, reinforcing the view that the site is important to the birds for resting and replenishing their nutrient reserves during spring migration. The data were compared with observations made of Bewick's Swans wintering in Gloucestershire, and also with the activities of birds grazing in fields in Estonia. There was no sexual difference in the feeding rates recorded for paired males and females at Matsalu Bay, although paired birds looked up for shorter periods whilst feeding than did single swans and cygnets. Bewick's Swans were observed mating in Estonia in spring 1987. Cygnets continued to associate with their parents during the spring migration.

The importance of migratory sites to birds for the development of nutrient reserves in preparation for the breeding season has been recorded in several species. Ebbinge *et al* (1982), for instance, found that weight gained at the staging areas in spring determined the reproductive success of Dark-bellied Brent Beese *Branta b bernicla*. Other studies have shown that food selection by geese ensured a high protein content in their diet in spring (McLandress & Raveling 1981; Ydenberg & Prins 1981; Thomas & Prevett 1982). A positive correlation between mild weather on the wintering grounds and subsequent breeding success was found for Whooper Swans *Cygnus cygnus* (Nilsson 1979), reinforcing the view that female condition on arrival at the nest site determines her breeding success. In the present study the activities of Bewick's Swans *Cygnus columbianus bewickii* staging at the Matsalu State Nature Reserve in Estonia are analysed and the amount of time that the birds spend in resting and feeding is described. Feeding rates recorded for paired males and females are compared to determine whether females feed more intensively in preparation for the breeding season. The effect of changes in climate upon the swans' activity patterns is taken into account.

Study Site

The Matsalu State Nature Reserve in western Estonia is a major staging area for Bewick's Swans on their 2,300 mile migration from wintering grounds in NW Europe to the breeding range. The reserve, established in 1957, covers an area of 39,697 ha, including the bay which extends to 26,273 ha, and coastal pastures of 2,300 ha (Paakspuu & Kastepold 1985). It receives legal protection to conserve the wealth of wildlife in the area and was designated by the Soviet Government as a wetland of international importance under the Ramsar Convention in December 1976. The maximum number of migratory swans recorded each spring has declined since a combined count of 40,000 Bewick's and Whooper Swans made on one day in spring 1957 (T. Kastepold and V. Paakspuu pers. comm.), to between 8,000-10,000 in 1963 and 1964 (Paakspuu 1967). Up to 2,000 Bewick's Swans and 4,000 Whooper Swans are normally recorded at the site between late April and early May in recent years. The decline in the number of swans staging at Matsalu Bay could be due to a general decrease in the number of Bewick's Swans in the NW European popula-

Supplement No. 1 (1991): 249-255

tion, to a change in conditions at the Matsalu Reserve or, most likely, to improved spring feeding elsewhere. Traditionally the swans at Matsalu feed on *Chara* species, which grows in shallow waters along the northern end of the bay, but in recent years increasing numbers have moved inland to graze.

Methods

The activities of Bewick's Swans at Matsalu Bay were observed from an observation tower near the village of Haeska, situated on the northern shore of the bay, between 21 April and 2 May 1988. On 3 May the activities of swans grazing inland at Turpla, 12 kms east of the Matsalu Reserve, were monitored. Birds could be seen at distances of up to 4 kms east and 4 kms west of Haeska with a telescope. The maximum number of Bewick's and Whooper Swans visible from the tower was recorded daily and included most of the Bewick's Swans present on the reserve during the study period.

Two methods were used to assess the swans' behaviour patterns. First the activity of each swan was recorded during flock scans made every 15 minutes. The percentage of the birds recorded as feeding, sleeping, loafing (i.e. sitting or swimming gently on water), swimming rapidly, flying or interacting with other swans was then calculated for each hour of the day. Weather data recorded for the area was made available (A. Polma, pers. comm.) to determine whether climatic conditions influenced the results. Flock scans recorded for Bewick's Swans wintering in Gloucestershire during the 1986-87 winter were compared with the Estonian data. Secondly, focal birds were observed continuously for periods ranging from 2 minutes to 43 minutes and their activities dictated to a tape-recorder. If the birds were paired or in a family party the behaviour of each member of the social unit was described during the observation period. The sex of the swan was estimated from its size since females tend to be smaller than males. Scott (1988) showed that the sex of 95% of paired swans and 78% of single swans can be assessed acurately in the field. The swans' activity patterns were translated via an electronic event-recorder into a character code for analysis on a BBC micro-computer. Data obtained from paired males and females were translated simultaneously so that interactions within the pair could be analysed. Single birds and cygnets were entered separately. It was not posible to consider the cygnets at the same time as their parents because of physical constraints in translating the data.

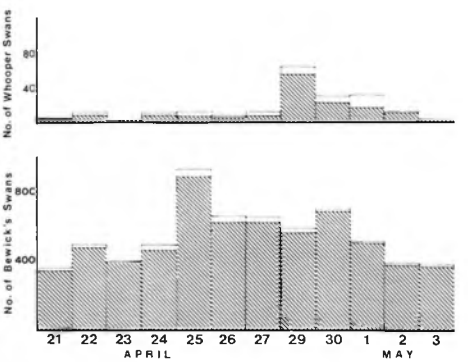

Figure 1. Counts of Bewick's and Whooper Swans made at Haeska, Matsalu Bay, Estonia between 21 April and 3 May 1988.

Statistical tests on the SYSTAT computer package were used to analyse the results.

Results

Swan counts at Matsalu Bay in spring 1988

The daily counts of both Bewick's and Whooper Swans seen from Haeska between 21 April and 3 May 1988 are given in Figure 1. The 350 birds recorded on 21 April represents less than a quarter of the 1,800 migratory swans counted in the Matsalu area during the day; 1,300 of the swans were found feeding in fields at the southern end of the reserve (V. Paakspuu pers comm). Up to 19 cms of snow, persistent northerly winds, and sub-zero temperatures from 22 to 26 April inclusive resulted in the swans moving from the fields onto the bay near Haeska, however, where most could be seen from the observation tower. It seems likely that the increase in the Bewick's Swan counts from 497 on 24 April to 928 on 25 April was due to the redistribution of birds already present in the area, rather than to large numbers of swans arriving at the site. Evans (1979) found that Bewick's Swans generally avoided migrating into northerly head winds during spring migration.

A small flock of 133 Bewick's and 1 Whooper Swan were recorded at Turpla and a separate group of 120 Whooper Swans at Kiili, but most of the swans remained on the northern shore of the bay near Haeska until their departure in early May (V. Paakspuu pers. comm.). On 1 May there were no swans present in the field that had held 1,300 just ten days earlier. The decline in Bewick's Swan numbers from 928 on

Table 1. Bewick's Swan activities recorded during flock scans made at Gloucestershire, G.B. during the 1986-87 winter and at Estonia during spring 1988.

SITE		TOTAL NO. OF OBSERVATIONS	% ACTIVITY							
			Feed	Sleep	Loaf	Preen	Stand	Sit	Display	Other
ESTONIA	(Haeska, overall	55148	59.0	24.5	1.3	6.5	1.2	0.9	1.0	5.6
	(Haeska, on 21.4	1977	25.9	38.2	2.7	12.3	2.7	2.7	1.0	14.5
	(Turpla, on 03.5	2973	31.9	38.6	0.2	11.6	8.4	4.6	0.6	4.1
G.B.	(Fields, pre 1.1	2624	68.5	7.8	2.1	12.8	2.5	1.1	0.3	4.9
	(Fields, post 1.1	6442	48.5	21.7	4.4	10.4	9.1	1.6	2.2	2.1
	(Rushy Pen, Glos.	14646	10.2	27.0	23.2	20.8	7.4	2.4	1.5	7.5

Note: "Other" activities includes drinking, pre-flight signalling and flight. "Preen" also includes scratching, shaking and other comfort movements.

25 April to 650 on 26 April and 365 by 3 May can therefore be attributed to swans leaving the area to continue their migration to the breeding range.

Figure 1 shows that, on average, Bewick's Swans outnumbered Whooper Swans by a ratio of 33:1 during the 1988 study period. By comparison a maximum count of 6,220 migratory swans made at Matsalu Bay in spring 1987 included 1,450 Bewick's Swans, which agreed with the more usual ratio of 3:1 Whooper Swans to Bewick's Swans recorded at the site in recent years (V. Paakspuu, pers. comm.). It seems, therefore, that the low maximum count of 1,800 migratory swans reported during the 1988 season could be attributed to the absence of Whooper Swans from the area. The mean percentage young was 4.2% Bewick's Swan cygnets and 24.6% Whooper Swan cygnets (see Fig. 1). The Bewick's Swan figure was lower than the 8.5% juveniles recorded amongst up to 3,787 Bewicks's Swans wintering on the Ouse Washes, Norfolk, G.B. during the 1987-88 season (Rees 1988a).

The activities of Bewick's Swans at Matsalu Bay

The activities recorded for each of the Bewick's Swans monitored during the flock scans at Matsalu Bay showed that, on average, 59.0% of the birds were feeding, 24.5% were sleeping, 6.5% were preening, and 1.3% were loafing. Other activities, including active swimming, sitting, drinking, flying and aggressive encounters, accounted for 8.7% of the behaviours recorded (Table 1). Aggressive encounters were all between separate social units - parent birds did not appear to threaten their cygnets. Courtship and mating behaviour was not observed, although the ritualised washing and prolonged preening by one pair seen on 2 May suggested that mating may just have taken place. There are two known cases of Bewick's Swans observed mating in Estonia; the first was a pair near Kolmenasva at Matsalu Bay on 26 April 1987 (V. Paakspuu pers. comm.) and the second pair was observed by ECR at Koplilaht Bay, Tallinn on 29 April 1987. The daylength between 21 April and 2 May ranged from 14.95 to 15.85 hours, with a mean value of 15.39 hours. Since 59.0% of the swans were recorded as feeding during the flock scans made throughout the day during this period, it is estimated that this represents an average 9.08 hours per day spent feeding by each bird, although it is likely that individual birds differ in their feeding activities.

An analysis of the activities of Bewick's Swans in Gloucestershire during the 1986-87 winter showed that, on average, 54.3% of the swans in the fields and just 10.2% of swans in the Rushy Pen, Slimbridge (a major roost site for swans in the county, where the birds also feed on grain distributed three times a day) were recorded as feeding during the flock scans (Table 1). Both these figures were significantly lower than the proportion of swans seen feeding at Haeska ($\chi^2 = 69.7$, $P < 0.001$ and $\chi^2 = 10989.5$, $P < 0.001$). Between October and December 1987 when Bewick's Swans were arriving to winter in Gloucestershire (Rees 1988b), the percentage of feeding activity in the wintering flock (68.5%) was significantly higher in comparison both with Gloucestershire datum gathered after 1 January ($\chi^2 = 298.94$, $P<0.001$) and with activities recorded at Haeska ($\chi^2 = 93.8$, $P < 0.001$, see Table 1). The mean daylength recorded during the autumn study was just 8.59 hrs (range 7.47 to 9.95 hrs), however, so the average length of time that the birds spent feeding was estimated at 5.9 hrs per day between 28 October and 21 December. Similarly, the mean daylength for the period after 1 January

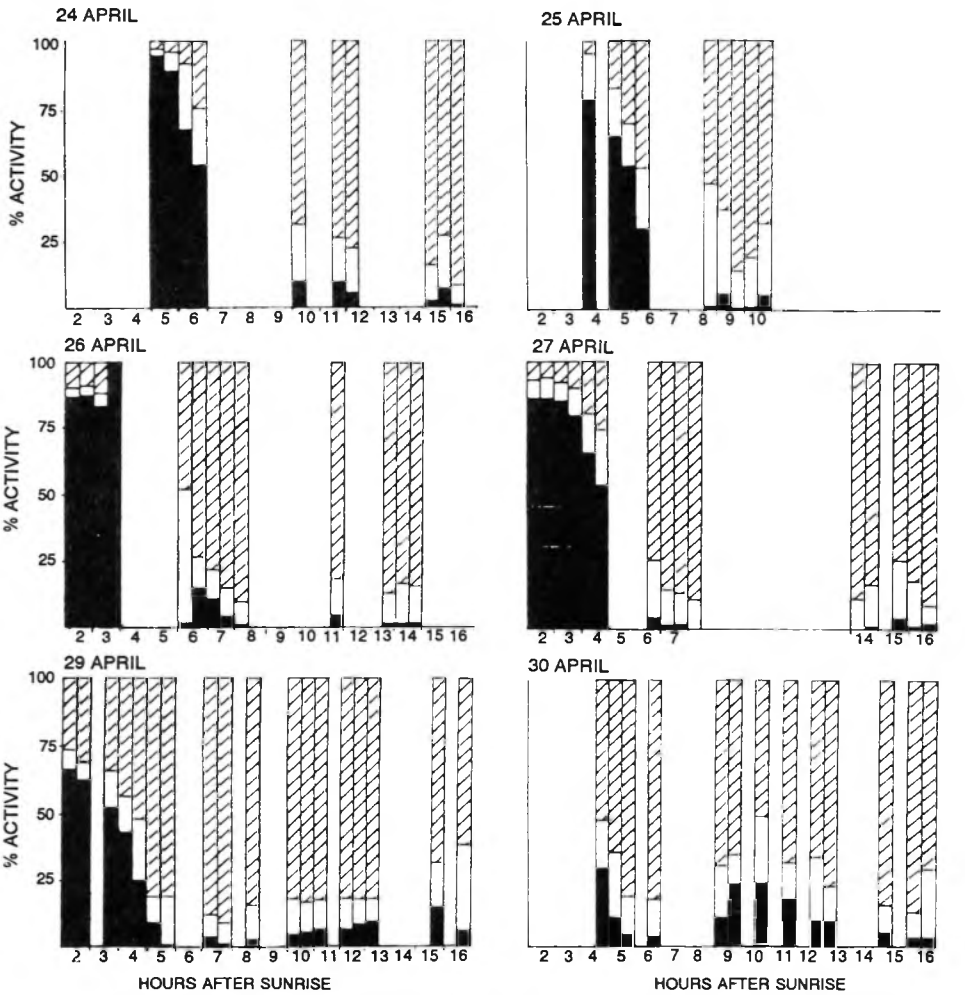

Figure 2. Activities of birds recorded during flock scans at Haeska between 22 and 30 April 1988. ▨ = Feeding ■ = Sleeping □ = Other activities

was 10.14 hrs (range 8.32 to 11.69); and the average time that the birds spent feeding was estimated at 4.9 hrs each day. Even though the swans spent a higher proportion of the daylight hours in feeding during the autumn, therefore, just 5.9 hours of the day were spent in ingesting food, compared with 9.08 hrs at Matsalu Bay.

The results of the flock scans obtained at Haeska between 15.00 and 21.30 hrs GMT on 21 April differed from the pattern noted during the remainder of the spring study period; just 25.9% of the birds were feeding compared with 38.2% sleeping (Table 1). Moreover, subsequent observations indicated that the swans usually slept during the first part of the day (Fig. 2). The high proportion of birds seen sleeping during the afternoon and evening of 21 April may perhaps be due to swans resting having just arrived at the site. The proportion of swans observed feeding on the grassland at Turpla (31.9%) was also significantly lower than on Matsalu Bay ($\chi^2 = 845.5$ $P < 0.001$), but local people had cleared an area of snow and fed the birds with grain following the blizzards on 22 April, so conditions were more similar to the Rushy Pen at Slimbridge. The swans at Turpla were feeding in a stubble field of rye *Secale cerale*, which was producing fresh growth and had been under-sown with clover *Trifolium repens*. An analysis of eight swan faeces collected at Turpla indicated that the birds were mainly selecting the young rye shoots; 95% of the vegetative species, identified by the cell structure of the epidermal layers viewed under

Table 2. A comparison of the percentage of time spent on different activities by 52 pairs, 39 single birds and 10 cygnets.

Activity	PAIRED SWANS Males	PAIRED SWANS Females	SINGLE SWANS Males	SINGLE SWANS Females	CYGNETS
% FEED (Head up	8.44	9.00	19.56	18.20	13.88
(Head down	69.78	69.22	68.02	62.66	73.60
% DISPLAY	1.46	1.17	0.94	0.49	0.00
% SWIM	5.33	4.09	1.66	3.40	4.23
% PREEN	2.39	3.43	2.34	6.77	1.69
% OTHER	12.60	13.09	7.48	8.48	6.60
Duration of observations (secs)	21520.8	21520.8	7347.6	13472.8	4605
No. of focal birds	52	52	15	24	10

a microscope, were rye whilst just 5% of the swans' diet consisted of clover. An analysis of the food ingested by Bewick's Swans wintering in Gloucestershire similarly showed that swans do not select *Trifolium* species; clover constituted 1% of herbage in the fields and only 0.1% of vegetation in the faeces (Rees 1990).

Changes in the swans' feeding patterns at Matsalu Bay

Table 1 indicates that feeding and sleeping accounts for 83.5% of the swans' activities at Matsalu Bay. There was a significant inverse correlation between the numbers of swans recorded as feeding and sleeping during the flock scans ($r_s = -0.531$, df = 214, $P < 0.01$, Spearman Rank Correlation), and the amount of time spent feeding increased during the course of the study (see Fig. 2). The high proportion of birds found to be sleeping during flock scans on 21 April, the first day of the study, is reported on page 252. Thereafter the general pattern was that most of the swans were asleep when observations commenced in the morning but intensive feeding activity was maintained from mid-day onwards. The number of hours from sunrise to the point at which 50% of the flock were first recorded as feeding, which varied from 10.04 hrs on 24 April to 4.74 hrs on 1 May, was inversely associated with the maximum temperature recorded each day ($r^2 = 0.34$, t = -1.9, df = 7, $P = 0.05$, Linear Regression 1-tailed analysis, Fig. 3).

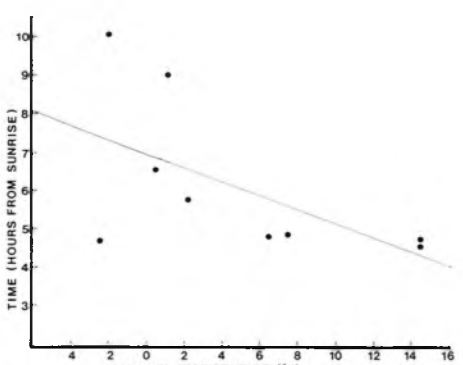

Figure 3. Regression of the time at which 50% of the swans had commenced feeding (measured in hours after dawn) against the maximum daily temperature.

A comparison of the activities of male and female swans on migration

The activities of 52 pairs of Bewick's Swans at Matsalu Bay were monitored continuously for periods of between 2-43 minutes to determine whether there was any sexual difference in feeding intensity between members of a pair. Wilcoxon tests showed that there was no difference between the two sexes in the number of seconds that paired males and females spent with their heads under water whilst feeding ($P = 0.678$), or in the amount of time that their heads were up during feeding periods ($P = 0.675$, Table 2). Paired males and females had their heads down for 69.8% and 69.2% of the total observation period respectively, however, compared with just 8.4% and 9.0% spent with the head-up whilst feeding. An analysis of the frequency with which paired males and females raised their heads above water confirmed that, although males looked up more often than females (on 1,282 occasions compared with 1,275 occasions), the difference was not significant (t = 0.06, $P = 0.95$, N=52 pairs, One-way analysis of variance). It seemed, therefore, that paired females do not feed for longer periods than their partners in spring, nor that males spend more time alert to protect their mates, although males did spend significantly more time than females in aggressive encounters with other swans ($P = 0.04$, Wilcoxon test, Table 2). It is possible, since Matsalu Bay is some 15,000 kms from the breeding range, that it was too early for sexual differences in feeding patterns to occur.

In order to compare the feeding activity described for paired swans with the behaviour recorded for single birds and cygnets, the percentage time spent by each focal bird on each activity was calculated and the data subjected to an arc-sin transformation for statistical analyses. Mann-Whitney U (2-tailed) tests showed that, although paired males and single males did not differ in the time spent with their heads down feeding (U = 424, $P = 0.614$, Table 2), single females tended to spend less time with their heads under water than paired females (U = 762, $P = 0.123$, Table 2). Single birds of both sexes looked up for longer periods than swans with mates (U = 136, $P < 0.001$ for males and U = 214, $P < 0.001$ for females, Table 2). Juvenile Bewick's Swans showed the most intensive feeding activity and had their heads under water for 73.6% of the focal bird observations (U = 697 and U = 1040 , $P < 0.001$ when compared with paired males and females repectively; U = 425 and U = 581, $P < 0.001$ when compared with single males and females, Table 2). Cygnets also looked up for longer periods than paired birds whilst feeding, (U = 136 and U = 214, $P < 0.001$), perhaps to ensure that they maintained contact with their parents.

Discussion

The flock scans at Haeska showed that the overall mean percentage of birds recorded as feeding was 59.0% (or 9.08 hrs spent feeding during 15.4 hours of daylight), compared with 68.5% (or 5.9 hrs per day) recorded feeding in Gloucestershire before 1 January, and 48.5% (4.9 hrs per day) feeding after 1 January. The difference in the two figures obtained for the wintering flock, which occurred despite the shorter daylength during the autumn period, may perhaps reflect the swans' need to replenish their nutrient reserves following the energetic demands of the autumn migration. Evans and Kear (1978) found that the weights of Bewick's Swans wintering at Slimbridge increased during November and early December, but reached a plateau by the end of the year. The difference in feeding intensity recorded in Gloucestershire in autumn, compared with Haeska in spring, may be largely due to the swans' attempts to maximise their food intake during the short periods of daylight upon arrival in the wintering range. The results may also be influenced by a rapid turn-over of swans in the Matsalu area; the high proportion of birds seen sleeping throughout the Estonian observations (and on 21 April in particular) may have needed to rest having just flown to the site. Swans tend to spend most of their first day sleeping upon arrival at Slimbridge in the autumn, but this detail was lost from the Gloucestershire data since information was gathered over several months. Alternatively the low percentage feeding activity at Haeska in comparison with Gloucestershire in autumn may be attributable to the adverse weather conditions experienced during the first week of the Estonian study; data needs to be collected over several years to determine whether there is a consistent difference in the swans' activites at the winter and migratory sites.

Other authors have shown that feeding activity decreases with falling temperatures (Paulus 1984, Quinlan & Baldassarre 1984). This study similarly indicated that the percentage of swans seen feeding each day increased with the maximum daily temperature, which advanced the thaw of ice on the bay. The swans' feeding pattern at Haeska was similar to the results obtained from the Ouse Washes, England, where the proportion of swans feeding increased during the day, with 80% of the flock continuing feeding after dark (Owen & Cadbury 1975). The extent to which the differences in feeding rates observed between the migratory and wintering sites is related to the quantity and quality of food available in these areas has yet to be analysed for swan species.

Observations of the feeding activities of individual birds showed that there was no sexual difference in the feeding intensity of paired males and females at Matsalu Bay, despite the possibility that there would be an advantage in the females developing fat deposits in preparation for egg-laying and incubation. Paired birds looked up for shorter periods than single swans whilst feeding, which probably enhanced their food intake during feeding periods, but they also spent more time swimming and in aggressive encounters. The heightened vigilance shown by single swans whilst feeding may be due to there being no mate to share the responsibility of detecting predators, although the risk would be reduced by the presence of other birds in the flock (Hamilton 1971). Cygnets, which showed the most intensive feeding activity, looked up for longer periods than paired birds, but not as long as single swans. Perhaps they benefited from being in a family group and so were able to spend more time feeding, but also needed to ensure that they were not separated from their parents. There was no evidence to suggest that parents rejected their cygnets during spring migration.

Visits to the Soviet Union in 1987 and 1988 resulted from a Winston Churchill Travelling Fellowship awarded to ECR and we wish to thank the Churchill Trust for their support and encouragement. The visit to Matsalu Bay was made possible through the kind cooperation of the Ministry of Forest Management and Nature Conservation of the Estonian SSR. In particular we thank Dr F. Nommsalu, Dr M. Lahtmets, Dr V. Paakspuu, Dr T. Kastepold, Dr A. Miilmets; Dr V. Lilleleht and Dr H. Veromann from the Academy of Sciences; and Dr F. Jussi. M. Owen and S. Dirksen made constuctive critiscisms on a draft of the text.

References

Ebbinge, B., St. Joseph, A., Prokosch, P. & Spaans, B. 1982 The importance of spring staging areas for arctic-breeding geese wintering in western Europe. *Aquila* 89: 249-258.

Evans, M.E. & Kear, J. 1978. Weights and measurements of Bewick's Swans during winter. *Wildfowl* 29: 118-122.

Evans, M.E. 1979 The effect of weather on the wintering Bewick's Swans *Cygnus columbianus bewickii* marked at Slimbridge, England. *Ornis Scand.* 10: 124-132.

Hamilton, W.D. 1971. Geometry for the selfish herd. *J. Theor. Biol.* 31: 295-311.

McLandress, M.R. & Raveling, D.G. 1981. Changes in diet and body composition of Canada Geese before spring migration. *Auk* 98: 65-79.

Nilsson, L. 1979 Variation in the production of young of swans wintering in Sweden. *Wildfowl* 30: 129-134.

Owen, M. & Cadbury, C.J. 1975. The ecology and mortality of swans at the Ouse Washes, England. *Wildfowl* 26: 31-42.

Paakspuu, V. 1967 Observations of the transit of swans along the west coast of Estonia. *Communications of the Baltic Commision for the Study of Bird Migration* 4: 46-52.

Paakspuu, V. & Kastepold, T. 1985. The waterfowl, marsh and shorebird fauna of the Matsalu wetland. In: *Matsalu - a Wetland of International Importance* (Ed. E. Kumari), Valgus, Tallinn.

Paulus, S.L. 1984. Activity budgets of non-breeding gadwalls in Louisiana. *J. Wildl. Manage.* 48: 371-380.

Quinlan, E.E. & Baldassarre, G.A. 1984. Activity budgets of non-breeding green-winged teal on Playa Lakes in Texas. *J. Wildl. Manage.* 48: 838-845.

Rees, E.C. 1988a. Swan Supporter Scheme seasonal report 1987-88. Wildfowl Trust, Slimbridge, Gloucester.

Rees, E.C. 1988b. Aspects of the migration and movements of individual Bewick's Swans. Ph.D. thesis, University of Bristol.

Rees, E.C. 1990 Bewick's Swans: their feeding ecology and coexistance with other grazing Anatidae. *J. Appl. Ecol.* 27: 939-951.

Scott, D.K. 1988. Breeding success in Bewick's Swans. In: *Reproductive Success* (Ed. T.H. Clutton-Brock), The University of Chicago Press, Chicago.

Thomas, V.G. & Prevett, J.P. 1982. The role of horsetails (*Equisetaceae*) in the nutrition of northern-breeding geese. *Oecologia* 53: 359-363.

Ydenberg, R.C. & Prins, H.H. 1981 Spring grazing and manipulation of food quality by barnacle geese. *J. Appl. Ecol.* 18: 443-453.