# Mute Swan flocks

C. D. T. MINTON

## Introduction

An intensive study has been made of the Mute Swan *Cygnus olor* population in an area of 550 sq. miles (1,440 sq. km.) in south Staffordshire. The area is based on National Grid co-ordinate SO 900900 and extends 40 squares (km.) north and 36 east. A previous paper (Minton 1968) gave details of the pairing and breeding behaviour determined from the first seven years of the study. The present paper deals with the flocks and, in particular, considers their size, age structure and status at different times of the year, and changes which have taken place over the ten-year period since the study was originated in 1961. In addition, movements of swans both between the flocks in the study area and over greater distances are analysed. A total of 2,568 swans were ringed in the course of the study, up to the end of 1970. Coloured ring codes were employed indicating the year of birth when known, the flocks in which the bird had been and whether it had been paired at any time. In the most recent years the large-numeralled Darvic rings developed for Bewick's Swans *Cygnus columbianus bewickii* (Ogilvie 1968) have greatly facilitated individual identification.

During the study period there has been a considerable local and national decline in the Mute Swan population (Ogilvie 1967). It was thus especially interesting to see how this change might be reflected in the flocks, particularly as a considerable proportion of the population are non-breeders, remaining in them throughout the year.

An additional feature studied was the effect of a major oiling incident in July 1966 which wiped out the majority of the moulting flock at Burton-on-Trent—the largest in the study area. The subsequent gradual recovery of its numbers and the permanent changes in its composition are detailed.

## Flock catching techniques

The main techniques for catching, and the colour ringing schemes adopted, have previously been outlined (Minton 1968). The ease of rounding up a complete flock depends on the geography of the site and on the weather conditions.

Although the flock at Burton-on-Trent was the largest in the study area it was the easiest to catch, being situated on a river complex with confined backwaters into which the birds could be shepherded. At Tamworth catching was most successful when the water level of the river was low enough for it to be waded, so that a barrier of swan catchers could be formed across it. However, over the years the Tamworth swans grew wise to the procedure and became increasingly difficult to catch, tending to call the swan catchers' bluff and take to the wing before they could be cornered. The whole flock adjourned to Alvecote Pools, three miles away, for the flightless period, when it was still possible to catch the majority of the birds. However, this was not possible at other times of the year when there was also a considerable movement of birds between Alvecote and Tamworth.

At Cannock, where the third main flock in the study area is situated on a small reservoir, complete rounding up has only been possible during the flightless period each year and during the severe winter of early 1963. On the latter occasion the birds were confined to a small area of open water in the frozen reservoir. In the early years of the study the small Stafford flock, located on a shallow section of the river Sow, was easily caught but as the numbers gradually decreased the few remaining birds became more scattered in less catchable areas on both sides of the town.

The flock at Rugeley, located on a wide and deep section of the Trent outside the town, was uncatchable. These swans lived exclusively by grazing on pasture land, were not interested in bread, and were completely unapproachable. Fortunately, like the birds at Stafford, they adjourned to nearby Blithfield Reservoir for the moulting period and there rounding up was practicable with the aid of motor boats.

Apart from the major round-ups outlined above, regular visits were paid to all the flocks throughout the year, maintaining an almost 100% ringed population in the study area. On such visits priority was given to catching unringed birds, particularly those in their first year, using a 12-18 ft. swan pole and bread as bait. Second priority was given to catching individuals which had not previously been recorded in that particular flock—these being identified by the lack of the local colour ring. Although the most detailed knowledge of the age structure

of the flock and the history of the movements of the individuals in it at any time could only be determined from the complete round-ups, some information could be obtained solely by examination of the colour rings.

**Population changes 1961-1971**

The numbers in a flock were recorded on each visit. It was therefore possible to determine fairly accurately the total number of Mute Swans in the flocks at any time. In addition synchronised counts were made of all the flocks each January, April and July to determine the winter, the spring non-breeding (more strictly, non-pairing) and the moulting flock populations respectively. The number of birds paired each spring and the number of young which they subsequently reared to the flying stage have been given up to 1967 by Minton (1968) and are now included up to 1970. Details of all these counts are shown in Figure 1.

*January flocks*

It might have been expected that the mid-winter flock counts would be the best indicator of the total swan population level. However, although the January figures show a general decline over the years, the pattern is extremely irregular and does not relate closely to the flock population at other times of the year. There is some correlation with the output of young in the previous year—a large winter flock population tending to follow a year of higher than normal production of young. However, the main factor affecting the January population in flocks appears to be the weather. In years when the count was made during or immediately following a spell of severe frost the population was significantly higher than in adjacent years when the weather was mild. Thus the highest population of all was recorded in the exceptionally cold spell in early 1963 when most paired birds and their offspring had to seek refuge in the flocks. Although some young birds and their parents begin to appear in the flocks in October, the main influx does not normally occur until much of the static water freezes and birds move from their breeding areas into the warmer unfrozen rivers in the towns. In open winters the final influx of young may be delayed until February when their parents drive them away in preparation for the new nesting season. Only the 1967 dip in the graph is associated with a real, marked and abnormal change in the swan population, following the destruction after oil pollution of about 75 swans in the moulting flock at Burton-on-Trent in July 1966.

The overall decline of the January flock population from 305 in 1962 to 164 in

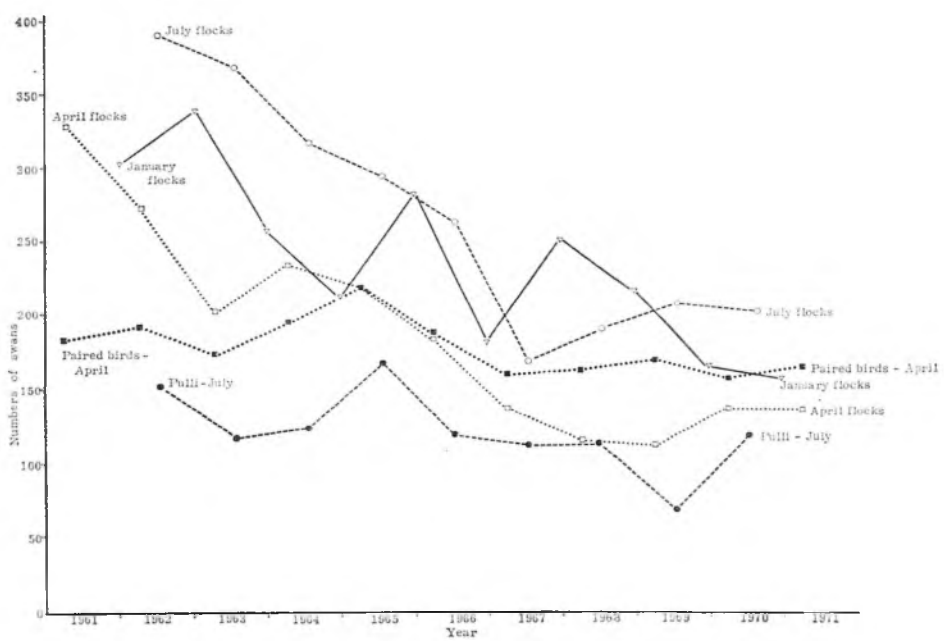


**Figure 1. Mute Swan flock population changes in south Staffordshire, 1961-1971.**

1971 represents a reduction of 46% in nine years—about 5% per annum.

*April non-breeding flocks*

The flock populations in the spring normally reach a minimum during the first half of April when almost all those birds which are going to pair that season have left to take up territories. Thus the flocks at this time represent the non-pairing portion of the total population.

The number of birds in the April flocks has shown a fairly steady decline since 1961 although there is some indication of a slight recovery in recent years. There were exceptionally large reductions in 1962 and 1963, following the severe winters, and a slight recovery in 1964, after which the decline resumed. The slight increase in 1970—unexpected since the production of young the previous year had been exceptionally low—may have been due to the late spring and cold weather, which continued right up to the end of April, discouraging some birds from pairing. However, this level was maintained in April 1971—helped by a mild winter and a better production of young the previous year—indicating that the general population decrease may have now ceased. The decline from 330 birds in the flocks in April 1961 to 139 in April 1971 represents a reduction of 58% in ten years—nearly 6% per annum. The whole of this net change took place in the first six-year period when the rate of decrease in the non-breeding flock population was nearer 10% per annum.

*July moulting flocks*

The flocks which gather to moult in July and August are composed of the non-pairing birds from the April flocks together with many of the birds which paired in the spring but did not subsequently nest. Some birds which nested but failed to breed also moult communally but others moult on their territory.

The July flock population showed a steady decline from 1962 to 1966 followed by a very steep fall in 1967. This latter reflects the wiping out by oil of the majority of the Burton-on-Trent moulting flock in July 1966. The subsequent increase in the moulting population in 1968 and 1969 is associated with the recovery of the Burton-on-Trent flock which, although it no longer moulted at Burton-on-Trent itself, did largely moult within the study area.

It appears that by 1969 the July population had recovered to the level it would have been expected to be at if the steady annual decline had continued. In the eight years from 1962 to 1970 the July flock population decreased by 47% from 390 to 207—6% per annum.

*Paired population and production of young*

Whilst the flock population has been decreasing at an average of 5-6% per year the paired population has been much more constant. Between 1961 and 1967 the paired population decreased by 10% from 186 to 168. From 1967 to 1971 it has been relatively constant. The average rate of decrease over the whole period has been only 1½% per annum.

In spite of the many different factors controlling the production of young the number reared to fledging each year has remained relatively constant. In six of the nine years for which complete data are available the number of young produced was between 115 and 125. In 1962 and 1965 it was well above this and in 1969 it was 40% less than the previous lowest total. Rather surprisingly the latter doesn't appear to have subsequently been reflected in the population levels of the flocks.

*Total population*

The total number of swans in the study area is the sum of the paired birds and the April flock population. The overall population was therefore 516 in April 1961 and this had declined to 307 in April 1971—a total of 40% in ten years corresponding to an average annual rate of decrease of 4%, though in fact most of this took place in the period up to 1967 when the rate was nearer 7% per annum.

The different rates of decrease have resulted in a steadily increasing proportion of the total population being paired each spring. In 1961 only 37% of the population was paired in the spring whereas by 1971 55% was paired. The maximum was 60% in 1969.

**Changes in individual flocks**

The overall decline in the swan population has been reflected differently in the various flocks (Table I). If the winter maxima at the beginning of the study period are compared with those of 1970-71 it can be seen that the main decreases have been in the smaller flocks —Lichfield and Rugeley have completely disappeared—and in the largest, at Burton-on-Trent.

The marked decrease of the smaller flocks, which presumably were in the less

**Table I. Changes in size of Mute Swan flocks 1961-1971.**

| *Place* | *Winter maximum* 1961-62 | 1970-71 | *Moulting (July)* 1962 | 1970 |
|---|---|---|---|---|
| Burton-on-Trent | 160 | 82 | 130 | — |
| Tamworth/Alvecote Pools | 57 | 50 | 45 | 120 |
| Cannock Reservoir | 30 | 23 | 52 | 52 |
| Stafford | 28 | 9 | 6 | — |
| Rugeley | 22 | — | — | — |
| Blithfield Reservoir | — | — | 128 | 35 |
| Lichfield | 7 | — | — | — |
| Others | — | — | 31 | — |
| | 304 | 164 | 392 | 207 |

suitable habitats, could be expected with a decreasing population. But other factors such as the removal of a weir, which lowered the water level on the Trent at Rugeley, and the cleaning out of the river at Stafford, which destroyed one of the most favoured resting places, may also have had an influence. The Lichfield site was not situated close to any natural river valley or swan 'flyways' and the scarce natural food supply and comparative lack of bread feeding by the public compared with other flock sites made it relatively unattractive to swans.

The habitat and the massive bread feeding by the public at Tamworth and at Cannock Reservoir have remained fairly constant over the study period and no significant change in the winter flock population at either has occurred.

At Burton-on-Trent dredging of exposed mudbanks and removal of a weir in 1964-65 has reduced the most suitable 'sitting out' areas on the main river where one-half of the population used to reside. Flocks now only occur on the smaller river where the geography is still unchanged, with ample resting areas. Bread feeding still continues on a large scale but presumably the smaller contact area with the public has reduced the total artificial food supply available and therefore the size of population which can be supported. Another factor which may help account for the halving of the Burton-on-Trent winter population over the ten year period is the large increase in the number of power lines in the Trent valley in and close to the town. Power lines are so often situated in river valleys for landscaping reasons, and power stations have to be situated adjacent to ample supplies of cooling water. The power station complexes at Drakelow and Willington are both within three miles. Ogilvie (1967) showed that nearly half the reported swan deaths are due to collisions with wires. The oiling accident in 1966 may also have contributed to the decline since the nucleus of highly resident and on the whole non-breeding swans was wiped out. Furthermore the loss of so many other potential breeders will have lowered the production of young in the area around.

Changes in the numbers have been even more marked in the various moulting than in winter flocks. The largest, at Burton-on-Trent, has never re-established itself after being completely wiped out in July 1966. Prior to that a large proportion of the wintering population remained at Burton-on-Trent to moult, with most of the remainder moving to Blithfield Reservoir and a few to Alvecote Pools Nature Reserve. Only that part of the population which left Burton-on-Trent annually to moult survived, because it was away at the time of oiling. It appears that the new birds which have gradually filled the vacuum created at Burton-on-Trent have followed the lead of the survivors in moulting elsewhere. However, in recent years Alvecote Pools has become the main moulting area for the Burton-on-Trent swans and the Blithfield Reservoir flock has decreased considerably.

It was thought possible that the catching techniques used at Blithfield Reservoir—following the individual flightless swans with motor boats—had caused the birds to go elsewhere to moult. This apparently happened at Abberton Reservoir in Essex when a similar technique was used. However, the same technique has been used at Blithfield in recent years and the flock has started to build up again, so this is therefore discounted as the main reason for the change in moulting population. Much of the decrease must be associated with the disappearance of the Stafford and Rugeley flocks which used Blithfield Reservoir as a moulting area.

The moulting flock at Cannock Reservoir—which is geographically rather isolated from the other flock sites in the study area—has remained almost constant over the whole period of the study.

**Age structure of the flocks**

After the first few years of the study the majority of the birds were of known age, having been originally ringed as pulli or first year birds. From the major round-ups of flocks it was thus possible to obtain an accurate knowledge of their age structure. Experience has shown that most unringed birds caught in the flocks which are not in first year plumage are in their second year—this being indicated by their dull beak colour and the occasional brownish rump feathers—hence the probable age of many other birds in the flock can be estimated. Younger swans tend to move around more and are therefore more likely to come into the study area from outside. Swans become more sedentary once they have paired for the first time at the age of two or three. Thus, although for detailed analysis the birds of known age were distinguished from those in which only the minimum age was known, for the general examination of age structure the two groups were amalgamated to increase the sample size, for example, birds of 'minimum age 2' were assumed to be two years old (Table II).

*Winter flocks*

The overall proportion of first year birds in the January flocks has remained remarkably constant at about 20% over the whole ten year period of the study, ranging only between 18% and 24% in spite of the variation in the production of young from year to year. Since the overall January flock population has decreased by 46% since 1962 while the average annual production of free flying young has decreased only slightly (except in 1969) it would appear that some factor is causing an increased mortality of the young before their first January. This is most likely to be the increased number of electricity and other wires since they form an especial hazard to young swans in their first few months of flight.

There have been some changes in the percentage of first year birds in the individual flocks over the years. Before the oiling incident at Burton in July 1966 the percentage of first year birds there in January averaged 17% but since then it has been 25-30%. This is because many of the old resident birds at Burton were killed. There has been a decrease in the proportion of first year birds in the Tamworth and Cannock flocks—which occasionally in the past would contain up to 30% in mid-winter—probably as a result of the somewhat reduced production of young locally.

The proportion of second year birds in the January flocks is higher than first year birds, presumably because many of the latter have still not left their family parties. The Tamworth flock averaged 45% second year birds whilst that at Burton averaged 30-40% up to 1966 and about 40% since then. Looking at the older end of the age scale the Tamworth

**Table II. Totals and percentage age composition of Mute Swan flocks rounded-up, 1962-1970.**

| | *Year* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | *1962* | *1963* | *1964* | *1965* | *1966* | *1967* | *1968* | *1969* | *1970* |
| JANUARY | | | | | | | | | |
| Localities | | | BT | BT | BT | B | B | B | B |
| Total | | | 190 | 138 | 195 | 90 | 144 | 41 | 52 |
| % 1st year | | | *21* | *18* | *21* | *28* | *23* | *29* | *35* |
| % 2nd year | | | *43* | *37* | *35* | *36* | *42* | *37* | *44* |
| % 3rd year | | | *14* | *14* | *13* | *14* | *16* | *15* | *10* |
| % 4th year or older | | | *22* | *31* | *31* | *22* | *19* | *19* | *11* |
| APRIL | | | | | | | | | |
| Localities | | T | BT | B | BTC | B | | B | B |
| Total | | 39 | 156 | 105 | 105 | 44 | — | 53 | 82 |
| % 1st year | | *59* | *42* | *40* | *48* | *66* | | *53* | *41* |
| % 2nd year | | *23* | *26* | *30* | *29* | *18* | | *30* | *41* |
| % 3rd year | | *13* | *12* | *9* | *4* | *5* | | *11* | *7* |
| % 4th year or older | | *5* | *20* | *21* | *19* | *11* | | *6* | *11* |
| JULY | | | | | | | | | |
| Localities | BCR | BR | BCR | BCR | BTC | TC | TCR | TCR | TCR |
| Total | | | 252 | 206 | 121 | 115 | 145 | 191 | 187 |
| % 1st year | *30* | *34* | *36* | *26* | *24* | *41* | *34* | *39* | *31* |
| % 2nd year | | | *24* | *33* | *32* | *30* | *35* | *23* | *28* |
| % 3rd year | | | *17* | *14* | *18* | *12* | *14* | *21* | *16* |
| % 4th year or older | | | *23* | *27* | *26* | *17* | *17* | *17* | *25* |

B=Burton-on-Trent; T=Tamworth/Alvecote Pools; C=Cannock Reservoir; R=Blithfield Reservoir

flock in January usually contained 10-20% which were four or more years old. The Burton flock on the other hand had 35% four or more year olds up to 1966 and 20% since then.

The average January flock composition in the study area at present can thus be summarised as: 1st year, 20%; 2nd, 40%; 3rd, 20%; 4th year and older, 20%.

*April non-breeding flocks*

By April most of the older birds and a proportion of the three and even of the two year old birds have paired and moved out to take up territories. The age structure of the non-breeding flocks remaining therefore shows a significant difference compared with mid-winter.

The percentage of first year birds is increased and has varied between 40% and 60% between 1962 and 1970—two or three times the winter level. In the earlier years the percentage was normally 50-60%, but in the last three years it has averaged only 40%. At both Tamworth and Cannock Reservoir the percentage of first year birds was close to 60% in the earlier years of the study but this has fallen steadily since 1966 and in the last two years has averaged about 30% at Tamworth and only 15% at Cannock (it was in fact only 11% in 1970). This pattern again suggests that fewer birds are surviving their first year than previously, although the slightly lower average production of free flying young is also a factor.

At Burton-on-Trent the normal percentage of first year birds in the April flock was 35-40% prior to the 1966 oiling incident. However, in 1967 it rose to 66% due to the loss of many second year or older birds the previous year and the fact that a large proportion of the newcomers which moved in to fill the vacuum were first year birds. The proportion dropped to 50% by 1969 and to 40% by 1970, but the latter will in part have been influenced by the exceptionally low number of young fledged in 1969 and therefore does not necessarily mean that the Burton-on-Trent flock has completely returned to its pre-oiling incident structure.

Up to 1966 about a quarter of the flock at Tamworth in April was second year birds. Since then no complete round-ups have been possible at that time of the year but an examination of the colour rings of the birds there, and at nearby Alvecote Pools, in April 1970 indicated that 35-40% were two year old birds. At Burton-on-Trent about a quarter of the population at that time of year in 1961-66 was aged two, but in 1967 the percentage dropped to only 18% as a result of the loss of many one year olds in the oiling disaster. The number has gradually increased since then and reached 40% in 1970—higher than before 1966 because of the loss of many of the old sedentary non-breeders from the Burton-on-Trent flock.

There was a substantial number of swans four or more years old in the April flocks in spite of the fact that most ought to be mature enough to breed. At Tamworth the percentage was only 5-10% but until 1966 it was normally 20-30% at Burton-on-Trent. However, with the influx of a new and younger population there the percentage has dropped to 10%.

The age structure of the present April non-breeding flocks is approximately: 1st year, 40%; 2nd, 40%; 3rd, 10%; 4th year and older, 10%.

*July moulting flocks*

The proportion of birds four or more years old is higher in July than April because some of the paired population return to the flocks to moult. Before the oiling incident at Burton-on-Trent in 1966 about a third of the population in July was more than four years old—similar to the mid-winter situation. At Alvecote Pools the proportion has been much lower, averaging 14% in 1966-1968 but rising to 18% in 1969 and to 22% in 1970. The absence of a hard core of old birds in the flock (as at Burton-on-Trent) accounts for the lower figure for Alvecote Pools and the gradual increase in recent years is associated with the ageing of the 'new generation' from Burton-on-Trent which goes there to moult. The percentage at Blithfield Reservoir has been variable but averaged only 15% over a seven year period—these birds being almost entirely failed local breeders. At Cannock Reservoir there is always a high proportion of swans in the July flock which have been paired in the previous spring and consequently the percentage aged four or more has been rather greater than in most of the other flocks, usually being between 20 and 30% and averaging 25%.

The proportion of one year old birds in the moulting flocks has varied in a way which does not appear to correlate with the production of young in the study area the previous year—although all one year old birds are in the flocks at this time. In 1962-1964 a third of the July population was in its first year; the proportion fell to 25% in 1965-66 and then rose to 40% in

1967-1969. However, the fall to 31% in 1970 did correspond with the exceptionally low number of young fledged in 1969. Apart from this the increase in recent years can be attributed to a fairly constant annual production of young in a declining population. But the changes in earlier years have no obvious explanation. There were no major consistent differences between any of the flocks.

The percentage of second year birds in the moulting flocks has varied around 30% at Burton-on-Trent and Alvecote Pools and 25% at Blithfield and Cannock Reservoirs. However, in 1965 it reached the exceptionally high figure of 53% at Cannock Reservoir, there being no obvious explanation.

The age structure of the July moulting flocks in recent years has thus been approximately: 1st year, 40%; 2nd, 25%; 3rd, 15%; 4th year and older, 20%.

**Occurrence of paired birds in the flocks**

Many paired birds remain on or near their territories throughout the year, even when they do not breed successfully. Others return to the flocks during the winter (especially in severe weather when their territory may be frozen over) or for the moulting period (particularly when they have not bred or have bred unsuccessfully). However, a few which have paired or even bred in the past will remain in the non-breeding flocks in the spring in a subsequent year. Thus swans which have been paired can be found in the flocks at any time of the year.

*January*

Since the Burton-on-Trent flock is situated close to the boundaries of the study area it is estimated that only about a third of the birds which leave there to breed take up territories inside the study area. The figures for the occurrence of previously paired birds in the flock have therefore been trebled to give a truer picture. Nevertheless, in most winters only 10% of the Burton-on-Trent flock has previously been paired. In the early years this rather low percentage was probably caused by the significant proportion of eligible birds in the flock which did not appear to take mates in the spring. A rather high proportion (21%) of previously paired birds occurred in January 1966 in a cold spell—which also caused a high overall flock population—due to many birds being frozen off their territories. In January 1967 the proportion was also higher than normal (18%) but this was an effect of the oiling incident; the *number* of previously paired birds was of the usual level (since they were mainly away on their territories at the time of the oiling) but the total flock was smaller.

At Tamworth nearly a quarter of the flock during the 1963 cold spell was composed of birds which had been known to be paired at some time previously. In other years the January flock contained only about 10% previously paired birds except in 1966 when (as at Burton-on-Trent) it was higher (at 16%) due to a short but severe cold spell.

*April*

Rather surprisingly the percentage of previously paired birds in the flock at Burton-on-Trent in April was no lower than that in January. This was partly due to the nucleus of swans in the flock which appeared to be disinclined to pair or only took mates irregularly. Some individuals even remained in the flock for several years without re-pairing. These flock residents were the main casualties of the 1966 oiling disaster with the result that in April there were no previously paired birds in the flock—in marked contrast to the situation in January 1967 when the figure was above average. Since then the April percentage has returned to the normal level of about 10%.

At Tamworth also the April flocks each year contained a small number of swans which had been paired in previous springs, averaging 5-10%. Most of these were individuals which had lost a mate and had not yet found a replacement and there was no hard core of reluctant breeders as at Burton-on-Trent.

*July*

During the moulting period flocks generally contained a higher percentage of previously paired birds than at any other time of the year. A large proportion of the pairs which did not have any young left their territories and retired to the major moulting sites. There is probably some advantage in leaving the limited confines of their territory for the security of one of the larger static waters generally favoured as moulting grounds.

At Burton-on-Trent in 1962-1966 about 15% on average of the July flock had been paired at some time previously. At Alvecote Pools in 1966-1970 the average was probably rather over 20% if some allowance is made for the proximity of the site to the edge of the study area and the consequent unknown paired birds which will have come to moult there

from outside. The percentage in the Blithfield Reservoir moulting flock was smaller and more constant, at about 12%, possibly a reflection of the generally higher breeding success of the swan pairs in the country areas more remote from human predation.

Cannock Reservoir, situated near the centre of the study area and relatively isolated from the main swan flight lines, provides birds which nearly all take up their eventual territories inside the study area. This region is the most plagued by human interference with nests and the failed breeders, as well as the non-breeding pairs, nearly all rejoin the flock to moult. Almost a third of the July flock had been paired at some time previously. The range was 20-44% the highest tending to correlate with years of poor breeding success (for example 1969).

As well as finding many known previously paired birds in the moulting flocks it was noticeable that in many new pairs caught in the spring both birds had been present in the same moulting flock the previous summer. It would appear that new partnerships are often first established in these moulting congregations and this accounts for the notable number of new pairs in early autumn. Such birds leave the moulting grounds together in September and spend several weeks moving around as a pair before re-entering the flocks for the midwinter period. A tenuous pair bond must still be retained, just as in other established pairs which adjourn into the flocks. These appear to submerge their aggressive instincts and pair bonds, yet often reappear still paired together the following spring.

It is noticeable that the only birds which have difficulty in replacing a mate are those whose territorial instincts are so strong that they never leave their old territory—and sometimes even drive off visiting unpaired swans which could perhaps be potential mates.

**Movements**

Although Mute Swans in Britain move around only locally, a small number travel quite long distances, occasionally crossing to the Continent. The information gained in the present study has therefore been analysed in an attempt to quantify the extent of movements, both between neighbouring flocks and over greater distances.

Of the total of 2,568 swans ringed in the study area and a further 86 swans ringed by others outside the area, and recaptured within it, three-quarters were subsequently heard of again, being retrapped, or reported via the British Trust for Ornithology ringing scheme. On average each bird was recorded three times subsequent to being ringed and therefore the total number of individual capture records was around 10,000 during the ten-year period. One individual was retrapped twenty times and quite a number more than ten times.

*Local movements*

There were approximately 2,000 records, involving around 1,000 individuals, of swans moving more than three miles (4.8 km.). However, the majority of birds were originally ringed in the flocks and must have in many cases already made a journey from their birthplace of greater than three miles.

Once in a flock however a small proportion of swans do remain remarkably static for several years. This was particularly true of the Burton-on-Trent flock until the 1966 oiling incident wiped out the most sedentary. One bird was captured nineteen times there between November 1960 and January 1967 and apparently only moved away from the area for the first time in April 1967. Another was recorded seventeen times between August 1961 and its death (due to oiling) in July 1966. Both these birds took a mate, but did not nest, in one or more years but only moved to a nearby backwater on the river to take up territory.

Numerous other birds were recorded for several years only in the Burton-on-Trent flock. Some may have moved at times to the east and north outside the boundaries of the study area. However, many appeared to remain stationary as they were recaptured both in the spring round-ups of non-breeding birds and in the summer moulting flock—the times at which one could most expect a mobile bird to be absent.

One bird, ringed as a paired bird in 1961 in Lichfield, moved to Cannock Reservoir 5 miles (8.0 km.) away in 1962 and was still present there in 1970. It had been caught seventeen times in the intervening period, mainly in the flock although it did take a mate on a nearby pond in several years.

The sedentary behaviour of birds in flocks over a long period may in part have been influenced by the proximity of the site to the territory which was occupied when paired. It is more normal for paired birds to take up territories rather further

away from the flocks and then only to occur irregularly in the flocks—generally when they have bred unsuccessfully. Thus the majority of birds make at least one other than local movement subsequent to the time when they were first recorded in one of the flocks.

*Movements between flocks inside the study area*

(*a*) Pattern of movements

In this section the movements between five main flocks in the study area are examined to determine the extent and pattern of intermingling of the population. A sixth flock, at Rugeley, was never catchable and disappeared in 1964. Only journeys which both start and finish in one of the flocks are included. Each movement is used and therefore a particular bird may be counted several times.

The numbers of individual movements between each flock are shown in Figure 2. It is apparent that there was most interchange between Burton-on-Trent and Tamworth/Alvecote Pools and between Burton-on-Trent and Blithfield Reservoir. There was also a substantial interchange between the Stafford and Blithfield Reservoir flocks, especially considering that the Stafford flock had always been smaller than the others and has virtually disappeared since the 1963 cold winter. Less extensive movements take place between the Cannock Reservoir flock and both the Burton-on-Trent and Tamworth/Alvecote flocks.

The most striking feature of the pattern of movements is the lack of interchange between the Cannock Reservoir and either the Blithfield Reservoir or Stafford flocks. These are all within ten miles (16.1 km.) of each other and form the closest group in the study area.

The pattern of movements appears to correlate closely with the height of the ground separating the various flocks. The 250 ft. and 500 ft. contours (76 m. and 152 m.) are shown in Figure 2. Burton-on-Trent, Tamworth/Alvecote, Blithfield Reservoir and Stafford are all connected directly by river valleys in which the ground level is below 250 ft.; these correspond exactly with the densest pattern of movements. Cannock Reservoir does not lie near a river system but is accessible from the east without traversing the 500 ft. contour: hence the moderate amount of interchange with the Burton-on-Trent and Tamworth/Alvecote flocks. Blithfield Reservoir and Stafford are separated from Cannock Reservoir by a barrier of ground over 500 ft.—Cannock Chase—

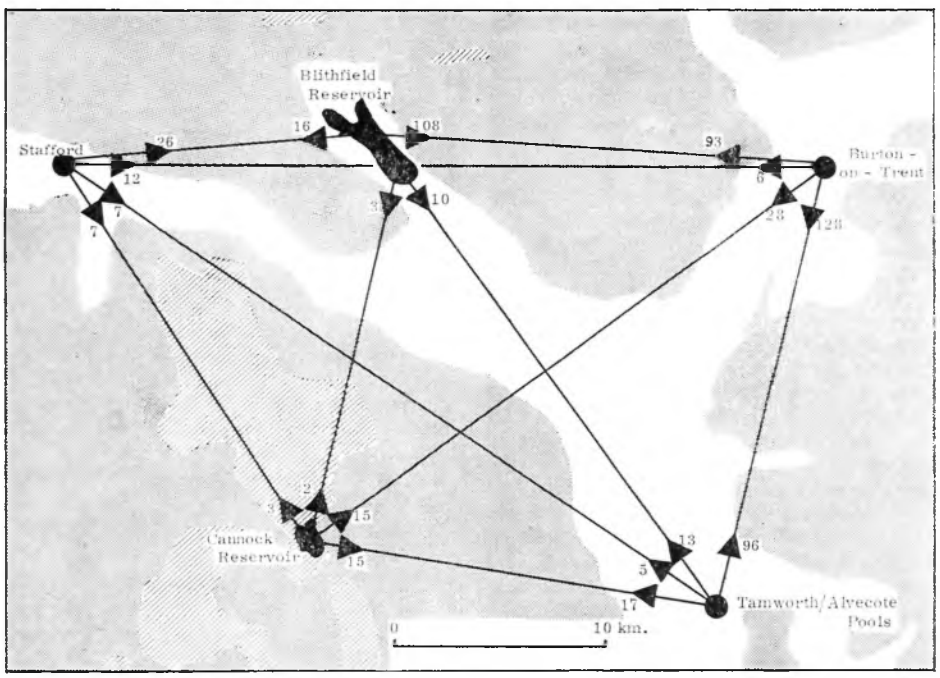


**Figure 2. Movement between the main Mute Swan flocks.** The hatched area is land over 500 feet (152 m.) and the stippled area is land over 250 feet (76 m.).

which appears to be the main inhibitor of movements between these flocks.

Several swans have visited a number of different flocks during their life. One did a circuit of four in only a year and a half:

| | | |
|---|---|---|
| 25.2.62 | 1st winter | Tamworth |
| 26.5.62 | | Alvecote Pools |
| 19.1.63 | | Cannock Reservoir |
| 10.3.63 | | Stafford |
| 28.7.63 | (moulting) | Blithfield |

Another oscillated mainly between two sites over nine years:

| | | |
|---|---|---|
| 23.10.60 | juvenile in family | Alrewas 6 miles (10 km.) SW. of Burton |
| 14. 1.62 | | Burton |
| 19. 5.62 | | Burton |
| 28. 7.62 | (moulting) | Blithfield |
| 28. 7.63 | (moulting) | Blithfield |
| 25. 4.64 | (alone) | Kings Bromley 4 miles (6 km.) SE. |
| 26. 7.64 | (moulting) | Blithfield |
| 24. 1.65 | | Burton |
| 25. 7.65 | (moulting) | Blithfield |
| 16. 1.66 | | Burton |
| 1. 1.67 | | Burton |
| 17.12.67 | | Burton |
| 13. 1.68 | | Burton |
| 25. 5.68 | (paired) | Blithfield |
| 27. 4.69 | (paired) | Blithfield |

Movements between the different flocks take place throughout the year, except of course during the flightless period of July and August. The Blithfield Reservoir flock is however only present during the summer months and it appears therefore that this flock, which assembles primarily for the annual moult, is drawn mainly from the Burton-on-Trent and Stafford populations. A proportion of the movements from Burton-on-Trent to Tamworth/Alvecote Pools are also moulting movements. Since the July 1966 oiling incident part of the new Burton-on-Trent population has tended to adjourn to Alvecote to moult instead of remaining throughout the summer. It thus appears that moulting congregations are largely drawn from specific flocks rather than being a random collection of all the birds from within a given radius.

Many swans have moved backwards and forwards between one flock and another several times. This is particularly true of birds undertaking a moulting movement. For instance many birds which have moved from Burton-on-Trent to Blithfield Reservoir or Alvecote Pools to moult have subsequently been recaptured back in Burton-on-Trent. Two extreme examples are:

| | | | |
|---|---|---|---|
| (1) | 14. 1.62 | 2nd winter | Burton |
| | 15. 4.62 | | Tamworth |
| | 28. 7.62 | (moulting) | Blithfield |
| | 23. 2.62 | | Burton |
| | 28. 7.63 | (moulting) | Blithfield |
| | 12. 1.64 | | Burton |
| | 18. 4.64 | | Burton |
| | 26. 7.64 | (moulting) | Blithfield |
| | 1. 5.65 | | Burton |
| | 25. 7.65 | (moulting) | Burton |
| (2) | 22.10.66 | juvenile in family | Polesworth 11 miles (18 km.) S. |
| | 30. 4.67 | | Burton |
| | 29. 7.67 | (moulting) | Alvecote |
| | 17.12.67 | | Burton |
| | 13. 1.68 | | Burton |
| | 24. 3.68 | | Burton |
| | 20. 7.68 | (moulting) | Alvecote |
| | 16. 2.69 | | Tamworth |
| | 1. 3.69 | | Tamworth |
| | 30. 3.69 | | Burton |
| | 9. 8.69 | (moulting) | Alvecote |
| | 9. 8.70 | (moulting) | Alvecote |

The first bird eventually changed its moulting site to Burton-on-Trent after three years at Blithfield Reservoir. Although most birds were consistent a few such changes occurred each year. Some even reverted back to their original moulting site after making a change. For instance a bird which moulted at Blithfield in 1964 and 1965, and at Alvecote in 1966 went back to Blithfield in 1968. In each year it was recaptured at Burton-on-Trent during the winter.

An example of the consistency of some moulting movements over quite long distances concerned two birds which were in the Alvecote Pools moulting flock in 1967. In the spring of 1968 they were paired together near Stafford (25 miles (40 km.) NW.) but after failing to breed they moved all the way back to Alvecote again to moult. In 1969 they were back at Stafford and having nested successfully did not have cause to return to Alvecote again. The female had originally been ringed as a pullus in the Stafford area (the male in the Burton-on-Trent winter flock) and it would appear that this may have accounted for this comparatively long regular movement.

(*b*) Composition of winter and spring flocks

In order to quantify the overall extent of movements the proportions of birds in each flock which have been recorded at some previous date in another flock have

been calculated. This was possible with the Burton-on-Trent and Tamworth flocks since virtually the whole population was rounded up several times a year at each place. At the other sites the whole flock was usually only caught up at the moulting time and therefore the analysis of the flock composition is mainly confined to the summer period. In all cases the percentages quoted refer only to the ringed birds of the flock, usually being a high proportion of the total.

At Burton-on-Trent about three-quarters of the flock rounded up each January was already ringed. In the period 1963 to 1966 about 15% of these previously had been recorded at Blithfield Reservoir and about 8% at Tamworth/Alvecote Pools. The proportion from Cannock Reservoir or Stafford was never more than 3%. Thus only about a quarter of the birds already carrying rings had previously been recorded in another flock. Another 15% of the ringed birds had been recorded away from Burton-on-Trent, mainly as pulli in their family parties at their birthplace, not in one of the other flocks.

Similar proportions of birds recorded in other flocks were present in the non-breeding flocks at Burton-on-Trent during April and May, except that the proportion from Tamworth had risen to 13%. This probably represented a genuine increase in movement during the spring between these flocks along the Trent/Tame valleys.

After the July 1966 oiling, the January flock composition changed quite markedly. The proportion from Tamworth/Alvecote more than doubled (to 18%). The percentage from Blithfield was rather variable, partly due to the decline in that flock, but in general it also increased averaging 21% in 1967-1970. Even the proportion of birds from Cannock and Stafford doubled—to a total of 7% on average in the period 1967-1970. The most striking increase of all, however, was in the percentage of the new Burton-on-Trent flock which had previously been recorded elsewhere in the study area, as pulli at their natal sites, or from outside the study area—in 1967 it was 32% and it remained around 40% in each year up to and including 1970. It would appear that the vacuum created by the loss of more than half the total population normally using Burton-on-Trent during the winter had created conditions which encouraged itinerant swans to stay. In all, about 70% had been recorded outside Burton-on-Trent at some time. The composition of the spring non-breeding flock after 1966 was also correspondingly more varied than previously.

The flock at Tamworth normally contained few birds from other flocks in the study area except Burton-on-Trent. The percentage which had at some time visited the latter was about 10% in mid-winter rising to 20% in the spring—the increase being due to greater movements at that time of year and also to the departure of the more sedentary local birds to breed. About a third of the flock had normally also been recorded at other places outside Tamworth—mainly as pulli at their natal sites.

The flocks at Cannock Reservoir and Stafford were not rounded up in the winter or spring frequently enough for any quantitative analysis of the origins of the birds but examination of the colour rings indicated that comparatively few of the swans in the former had previously visited other flocks in the study area.

(*c*) Composition of the summer moulting flocks

The size of the moulting flock at Burton-on-Trent in the period 1962-1966 was usually only a little smaller (up to 25%) than the peak numbers in the preceding winter. This was because the exodus of some birds to Blithfield to moult was counteracted by an influx of failed local breeders and of those one year old birds which had not joined the main flocks in midwinter. The composition of the flock was not dissimilar from that at other times of the year with about 9% from Tamworth and about 3% from Cannock and Stafford combined. The percentage of Blithfield birds was much smaller than in midwinter, due to these birds largely returning again to moult at Blithfield in subsequent summers. However the percentage ex-Blithfield did rise steadily, from 4% in 1963 to 11% in 1966, probably reflecting the increased sedentariness of birds as they got older and subsequently paired or bred in the area.

As already mentioned, the July 1966 oiling incident destroyed the moulting flock and there has not been a summer one at Burton-on-Trent since then. It seems as if the only survivors were those which were away moulting at Blithfield or elsewhere and that many new immigrants already had an established moulting area. One year old birds which had no previous moulting ground were presumably carried along in the exodus.

The Tamworth population moves completely to Alvecote Pools, three miles

(4.8 km.) away, to moult. The movement starts in mid May and all birds have usually transferred by mid June. The return largely takes place in September and during the period 1962-1966 the flock was not normally above about 50 birds, similar to that in midwinter. It was almost certainly predominantly made up of that population and the local failed breeding birds or non-breeding pairs. It was not possible to round up this flock until 1966 but in that year about a quarter of the ringed birds had at some time been in Burton-on-Trent—rather more than in the spring flock at Tamworth and this indicated some specific moulting movements. One bird had moulted at Burton-on-Trent in both the preceding years and another in 1965 only and both had therefore changed their moulting area. Another had moulted at Blithfield Reservoir twice before.

Recently there has been a steady increase in the size of the Alvecote Pools moulting flock, the July populations being 83, 105, 115 and 120 respectively in the years 1967-1970. This has in part been due to the lower success of breeding pairs at Alvecote, leaving a greater area of water free from aggressive adults. However, the main reason has been the adoption of Alvecote as the main moulting area for the swans which recolonised Burton-on-Trent after the 1966 oiling disaster. Thus in 1967 the percentage of Alvecote moulting birds which had been recorded at Burton-on-Trent had doubled (to 50%) compared with 1966 and in 1968-1970 it averaged 35%. In most years there were birds from Cannock Reservoir, Stafford or Blithfield Reservoir but these never amounted to more than 5% of the population. The Alvecote moulting flock is thus largely made up of the whole of the non-breeding population from the Tamworth flock, a large part of the Burton-on-Trent flock, and local failed breeders or non-breeding pairs.

The Cannock Reservoir flock was rounded up in the July in each of the years 1962-1970 except for 1963. The size of the moulting population remained remarkably constant, between 40 and 55, throughout this period. The majority of the flock was composed of the non-breeding birds present there throughout the winter and spring, and from the local paired birds which had either not bred or had failed in their breeding. On average only 8% had previously been recorded at Tamworth and a similar percentage at Burton-on-Trent—although the percentage from the latter averaged 12% in the 1968-1970 period reflecting the wider moult dispersal of the 'new generation' at Burton. There was never more than one bird from either Stafford or Blithfield Reservoir, indicating that the high ground of Cannock Chase is a deterrent to moulting movements as well as to movements at other times of the year. Compared with the other flocks in the study area the Cannock Reservoir flock is thus an almost closed community which has maintained its numbers during a period of general population decline.

The Blithfield Reservoir moulting flock has varied considerably in size. From 130 in 1962 it decreased to 70 in 1964, but after a slight rise to 90 in 1965 it showed a steep decline to 40 in 1966 and only 10 in 1967. The decrease is much more marked than in the population as a whole but this can, in part, be accounted for by the almost complete elimination of two of the flocks—at Stafford and Rugeley—which previously moved totally to Blithfield to moult. Thus the proportion of the Blithfield population which was known to have come from Stafford declined steadily from 30% in 1962 to 7% in 1965, after which no Stafford birds were recorded. This left only Burton-on-Trent as a principal source for the moulting population. The proportion from Burton-on-Trent rose from 34% in 1962 to 52% in 1965. The percentage from Tamworth was always small, averaging 6%, although in 1964 it was unusually high at 17%. Only the occasional bird from Cannock was recorded. The balance of the Blithfield moulting flock was made up of about 15% local failed breeders or non-breeding pairs and about 20% of birds from outside the study area. The latter were never seen between moulting seasons and had probably spent the intervening period in flocks at Stone or Stoke-on-Trent to the north-west outside the study area boundary.

The 1967 crash in the Blithfield population appears to have been an indirect result of the 1966 oiling incident at Burton-on-Trent. The draw to Alvecote Pools by the new population forming at Burton-on-Trent seems to have been greater than that of the survivors which returned from Blithfield.

Since 1967 there has been a gradual increase in the Blithfield moulting population again from 17 in 1968 to 35 in 1970. Nine of the eleven ringed birds in the 1968 population had come from Burton-on-Trent indicating the major

dependence of the Blithfield flock on that source. In 1969 70% of the flock was from Burton-on-Trent and in 1970 it was still 56%; in neither of these years was there a significant number of birds from any of the other flocks in the study area. It would thus appear that the capacity for any further increase in the Blithfield Reservoir flock is limited as the Burton-on-Trent population seems to have now re-stabilised itself and established a tradition that the major proportion uses Alvecote as its moulting area.

*Movements over longer distances*

(*a*) Distance of movements

During the ten-year study period only 75 movements greater than 30 miles (48.2 km.) were recorded from the 2,568 birds ringed in the study area, i.e. 3%. A further 48 birds ringed elsewhere were recaptured inside the study area after coming from distances of over 30 miles. Adding these to those mentioned above gives a figure of 5% of the total population captured in the study area moving more than 30 miles.

The number of swan movements falls off sharply with distance (Table III). About 60% of all the movements were controls, i.e. birds recaught by another ringer. However, as this percentage was the same for birds in both the 30-50 mile and the over-50 mile range it is not considered that the distribution of swan ringing activity has biased the apparent pattern of movements. Intensive ringing by J. A. Hardman at the Stratford-on-Avon flock, situated between 30 and 50 miles (48.2 and 80.4 km.) from the study area, produced only 16 birds from Staffordshire in eight years.

**Table III. Long distance movements of Mute Swans.**

| *Distance moved* (*miles*) | (*km.*) | *Number of movements* |
|---|---|---|
| 30-39 | 48-63 | 47 |
| 40-49 | 64-79 | 31 |
| 50-59 | 80-95 | 18 |
| 60-69 | 96-111 | 12 |
| 70-79 | 112-127 | 4 |
| 80-89 | 128-143 | 3 |
| 90-99 | 144-159 | 1 |
| Over 100 | over 160 | 7 |
| | | 123 |

Although long movements seem to relate largely to individual wanderers, on one occasion three birds from Tamworth turned up together at Stratford and had presumably travelled there as one party.

Seven birds returned to their original ringing place after making a journey of over thirty miles. Two of these birds made such movements in changing their moulting sites. One moulted at Blithfield in 1965, at Stratford-on-Avon (43 miles (69.1 km.) SSW.) in 1967, and back at Blithfield again the following two years. The other moulted at Stratford-on-Avon in 1966, at Alvecote Pools (30 miles (48.2 km.) N.) in 1967 and again at Stratford in 1968.

There were seven movements of over 100 miles (161 km.). The longest, of 140 miles (225 km.), was from Potter Heigham, Norfolk, to Tamworth. This bird was ringed in October 1962 and recaptured in January 1963, and therefore the long movement could have been partly due to the severe weather conditions. The other six were all caught in the summer at Barrow-in-Furness, Lancashire — a distance of 115-120 miles (185-193 km.). The four movements *to* Barrow all referred to birds caught in the study area in the winter and spring. Similarly both birds which moved *from* Barrow were recaptured in the study area in the winter. It is thought that these movements constitute a moult migration since birds from other parts of England have been caught at Barrow and the flock only forms there during the summer moulting period. One of the birds had originally been ringed in Oxford in March 1965 and was recaptured in the study area in May, presumably on its way to Barrow where it was recorded in July 1965. Another bird was recorded making the journey in both directions—ringed in August 1965 at Barrow it was captured at Tamworth in February 1967 and had returned by January 1968 to Barrow where it later nested. The other Barrow-ringed bird was also subsequently found nesting, but this time in the Midlands—ringed in September 1965 it bred in 1967-1969 at Walsall, Staffs.

(*b*) Direction of movements

The direction of movement of the 78 birds travelling 30-50 miles (48.2-80.4 km.) is shown in Figure 3. Birds from all the main flocks have shown these movements roughly in proportion to the numbers ringed, except for the Cannock Reservoir flock which appears to be rather less prone to long distance movements. Although the movements show a considerable spread there is a clear inhibiting effect of ground over about 500 ft. (152 m.), as was shown up in the examination of the more local movements.


**Figure 3. Mute Swan movements of between 30 and 50 miles (48.2 and 80.4 km.).** Land over 500 feet (152 m.) is hatched.

Thus there is an almost complete absence of northward movements due to the Pennines, and of long south-westward movements due to the Long Mynd, Clee and Malvern Hills. Movements to the south-east are sparse due to the Northamptonshire and Rutland extensions of the Cotswold range. In contrast there is a heavy concentration of movements across low ground along the Trent Valley, over into the Avon and Severn valleys, and to Shropshire and the Cheshire Plain.

The pattern of movements of the 45 birds which moved more than 50 miles is even more markedly affected by geographical features than the shorter movements (Figure 4). The heaviest concentration is to the north-west where there is uninterrupted low ground across Cheshire and Lancashire right up to Barrow-in-Furness. The Pennines again appear to be a complete bar to direct northward movements. Long westerly movements are inhibited by the mountains of Wales, the only recovery in that direction being at Welshpool, still in the Severn Valley. There is a fairly random scatter in an easterly and southerly direction, although the southern end of the Coltswold range appears to be another definite barrier. The concentration of movements between the study area and Oxford is probably over-stressed by the extensive ringing activity there (Perrins and Reynolds 1967) for although there is a direct route below 500 ft. most of the ground between is above 250 feet and comparatively waterless. One bird was caught at Stratford prior to Oxford and it is possible that most travelled that route. The movement from Alvecote to London is rather surprising since the Chiltern Hills lie between. Since five years elapsed between ringing and recovery it is possible that the journey was via Oxford and the Thames Valley. Movements into the Fens presumably took place via the gaps in the intervening high ground.

A notable feature is the lack of movements down the Trent Valley beyond Newark in spite of the extensive low ground in Lincolnshire right up to the Humber estuary. There have been no recoveries at all in north Lincolnshire or Yorkshire, in sharp contrast to the extensive movements into Lancashire. It would appear therefore that long movements to the north-east from the study area are inhibited by some other factor.

Most birds undertaking long movements and captured several times had either shown a consistent movement in

one general direction or had retraced their paths back to their point of origin. However, one bird was recorded making notable journeys in markedly different directions. Ringed as a first winter bird in Nottingham in January 1964, it was recaptured (moulting) 22 miles (35.4 km.) WSW. at Burton-on-Trent in July. It remained there until at least the following May but was subsequently caught 55 miles (88.5 km.) east at Deeping St. James, Lincs., in July 1966.

(*c*) Age at movement

Ninety of the 123 birds which moved more than 30 miles were of known age when ringed. For 50 birds the exact year of movement was known—the year being taken as June to June since most young are hatched by the end of that month. Almost equal numbers moved in the first and second years (23 and 21) and hardly any in the third and fourth (4 and 2). Since there are fewer two year old than one year old birds, long movements tend to occur most frequently during a swan's second year of life. Both birds which moved in their fourth year were returning over a route previously travelled and were therefore not breaking new ground.

In a further 27 birds the year of movement could be tied down to a two year period, i.e. first or second (14), second or third (12), third or fourth (1). All but one *could* have moved during their first two years of life. The remaining 13 birds were in their first two years when ringed but as they were not recovered for three or more years it is not possible to determine the age at which the major movement occurred.

Among the few birds which continued to make further major journeys after their second year was one with the following history:

| | | |
|---|---|---|
| 12.12.61 | 1st winter | Bewdley (48 miles (77.2 km.) S.) |
| 28. 7.62 | (moulting) | Blithfield Reservoir |
| 28. 7.63 | (moulting) | Blithfield Reservoir |
| 12. 1.64 | | Burton-on-Trent |
| 11. 7.65 | (with brood) | Leicester (25 miles (40.2 km.) ESE.) |

Another which moved from Chester to Burton-on-Trent (58 miles (93.2 km.) SE.) by the time it was two and a half years


**Figure 4. Mute Swan movements of more than 50 miles (80.4 km.).** Land over 500 feet (152 m.) is hatched.

old subsequently moved on a further 44 miles (70.7 km.) SW. to Droitwich.

The relationship between mobility and age generally fits in well with the known features of swan behaviour. Cygnets normally remain with their parents for six months (some even remain nine months) and thus the opportunity for movement in the first year is somewhat restricted compared with the second year. Furthermore, the first movement of significance is usually into the nearest non-breeding flock where the birds often remain for a while.

It appears as if the maximum mobility occurs in the spring and also during the moulting movements in early summer. However, in mid-winter swans may move out to take advantage of newly flooded pastures, intermingle with birds from other flocks and sometimes return in company with them to new places.

The study of the paired and breeding segment of the population (Minton 1968) showed that its movements were very circumscribed, particularly once nesting had actually taken place. Half the birds first pair at the age of two, and over 80% by the time they are three. It appears therefore that the growth of territorial instincts causes the decline in long movements after the second year of life. Many birds which had moved long distances into the study area from outside subsequently stayed to breed there and became relatively sedentary.

## The 1966 oiling pollution at Burton-on-Trent

Several mentions have already been made of some of the consequences of the oiling disaster at Burton-on-Trent but it seems desirable to bring this information together to present a comprehensive account of the history of the flock there since the incident.

The oiling took place on 5th July 1966 as a result of a major oil spillage into the River Trent at Drakelow Power Station, two miles (3.2 km.) upstream from Burton-on-Trent. The flock numbered about 90 at the time and 75 of these (64 carrying rings) were so badly oiled that they had to be destroyed. Most of the swans which normally left Burton-on-Trent to moult elsewhere (for example Blithfield Reservoir) had already departed and all the failed local breeders had not moved in.

Eighteen of the ringed birds had been caught at least six times there (eight of them more than twelve times). Thirty-seven had moulted at Burton-on-Trent before, ten of them in each year since 1962. Twenty-one of the sixty-four ringed birds were aged four or more and many of these had never been known to have taken a mate. Thus the main casualties were highly resident flock birds, some of which had been at Burton-on-Trent for several years.

The size of the flock at Burton-on-Trent from 1961-1971 is shown in Figure 5. After the oiling the few survivors moved off and it was not until October that the first swans returned. These were presumably some of those which had been away to moult but they soon began to attract other passing swans and the juvenile birds which had left their family parties locally. From a maximum of 20 birds in October the flock built up to 40

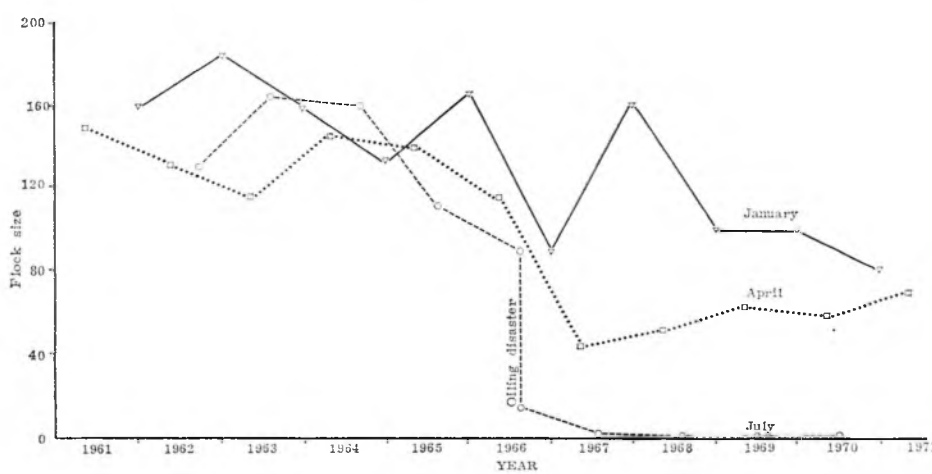


**Figure 5. Mute Swan flock sizes at Burton-on-Trent, 1961-1971.**

in November and to 90 in January. This was still 75 below the previous January. There were rather more birds than usual from the distant parts of the study area (for example Cannock Reservoir) and immigrants from further afield had come from Nottingham, Leicester and Chester.

The non-breeding flock in April 1967 numbered only 42, or 74 down on the previous year. New long distance immigrants had come from Leicester and Prestwich, Lancs. In July only four swans stayed to moult. Thus in the first year after pollution the Burton-on-Trent flock remained well below its previous level and only a small proportion of the loss was made good by an additional influx of swans from elsewhere inside and outside the study area.

Since 1967 there has been a continual slow increase in the flock numbers. This is best illustrated by the April figures, which recovered to 70 in 1971—a figure which the original population might well have reached in view of the gradual overall decline. The January figures have usually not exceeded 100—well down on the average of 160 in the first five years of the study. The exception was January 1968 when a hard spell caused most of the paired birds and their offspring to leave their territories and join the flock. In this flock of 160 were many more birds than usual from far afield—from Worcester, Oxford, Lincoln, Leicester, Prestwich, Chester and Winsford. It would appear that the vacuum created by the loss of a significant portion of the Burton-on-Trent flock has caused more of the passing wandering swans to remain, presumably because the food supply (mainly bread fed by the public) was sufficient. However, the immigrants have never re-established the July moulting flock and this is the main permanent change caused by the oiling disaster.

The total swan population in the study area is probably now little different from what it would have been if there had been no pollution in 1966. However, the character of the Burton-on-Trent flock has changed considerably. The flock composition is now more similar to that of other flocks in the study area, with an average age well below that of the flock before 1966. This is particularly true of the spring non-breeding flock which now contains few old birds. It is not clear what kept so many old (aged four or more) birds from pairing in the past and it is a pity that the study did not run an uninterrupted course to see if such birds did eventually pair. With the present lower population at Burton-on-Trent, pairing does not seem to be inhibited. But one cannot easily see why the previous larger population should have restricted pairing. Although the problem of finding a suitable territory near Burton-on-Trent would have been greater with the bigger flock, birds in the flock would not have known this until *after* they had paired and flown out of the flock to look for a territory. And in every year there have been many apparently suitable waters—both static and flowing—in the Burton-on-Trent area (as well as elsewhere in the study area) which have not been occupied. Both before and after 1966, shortage of territories would not appear to be the main factor controlling the size of the non-breeding flocks in spring. It remains to be seen whether the Burton-on-Trent flock will grow any further and if a new nucleus of old, non-pairing birds will build up in the future.

## The future

The Mute Swan population in south Staffordshire is still in a state of flux, though the major changes of the early part of the last decade have apparently slowed down considerably. The main factors which caused the population decline were probably:—

*a* the increased number of overhead wires to which first and second year swans appear especially vulnerable;

*b* the exceptionally severe weather in the 1961-62 and (especially) the 1962-63 winters (again, the younger birds are less likely to obtain food when competition is intensified);

*c* the lower production of young due to increased destruction of the nests by humans.

These suggestions are consistent with the greater decline in the flock population than the paired population. Recent mild winters have provided every opportunity for maximum survival and it remains to be seen what course the population takes in the future and what factors affect it.

## Acknowledgements

I am most grateful to the many individuals who have helped me over the years with the field work associated with this study. Large round-ups of flocks would not have been possible without a team of 10-20 people who were prepared to turn out in all weathers. I would

particularly like to thank E. J. Pratley, B. J. Cross, W. E. Merrill, I. Taylor and S. C. Brown as well as those mentioned in the earlier report.

I would like to thank the Alvecote Pools Nature Reserve Committee for permission to visit Alvecote Pools, and the South Staffordshire Waterworks Company for permission to visit Blithfield Reservoir, and particularly for the provision of motorboats to enable the moulting flock to be rounded up.

I am also indebted to the Wildfowl Trust for financial support and for the making of coloured Darvic rings. Since 1966 the Central Electricity Generating Board have kindly helped with expenses, in generous recognition of the disruption caused to the study by the oil leak from Drakelow Power Station.

Prof. G. V. T. Matthews and M. A. Ogilvie of the Wildfowl Trust staff have been most helpful in discussions and very tolerant of the problems faced by an amateur attempting to work up a mass of information in his spare time.

The British Trust for Ornithology gave permission for the use of recovery data.

Finally, I must thank my family who not only help with the field work but all too often have to put up with me sitting at my desk doing 'swan paper work'.

**Summary**

This paper considers all aspects of the nature and function of the Mute Swan *Cygnus olor* flocks in a 550 sq. mile (1,440 sq. km.) area of south Staffordshire studied from 1961-1971. During this period the flock population has declined at an average of 5-6% per year and several of the smaller flocks have disappeared. With the spring paired population decreasing at an average of only 1% per year there has been a change from nearly two-thirds of the population being unpaired each spring in the early years to less than a half in recent years. The age structure of the flocks at various times of the year has been detailed and major differences between flocks illustrated. Birds which have previously been paired occur in the flocks at all times of the year, being at a peak in the summer moulting congregations. Swan movements are mainly governed by a reluctance to traverse ground above 500 feet (152 m.) and a strong preference to travel along river valleys and low ground below 250 feet (76 m.). Significant interchange takes place between flocks up to about 15 miles (24 km.) apart, but only about 5% of the population moves further than 30 miles (48.2 km.) and only 1-2% more than 50 miles (80.4 km.). The majority of long movements take place in the first two years of life, particularly the second year. Regular movements to special moulting sites occur annually. The oiling disaster at Burton-on-Trent in July 1966 wiped out a large proportion of the resident flock and the subsequent gradual recovery of numbers has been recorded. The total population in the study area may now have stopped declining.

**References**

MINTON, C. D. T. 1968. Pairing and breeding of Mute Swans. *Wildfowl* 19 : 41-60.

OGILVIE, M. A. 1967. Population changes and mortality of the Mute Swan in Britain. *Wildfowl Trust Ann. Rep.* 18 : 64-73.

OGILVIE, M. A. 1968. The Bewick's Swans, 1967-68. *Wildfowl* 19 : 162-4.

PERRINS, C. M. and C. M. REYNOLDS. 1967. A preliminary study of the Mute Swan, *Cygnus olor*. *Wildfowl Trust Ann. Rep.* 18 : 74-84.

Dr. C. D. T. Minton, Elm Croft, 65 St. John's Hill, Shenstone, Lichfield, Staffs.