NATIONAL MUTE SWAN SURVEY 1990

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INTRODUCTION

Following the ban in England and Wales on most sizes of lead weight for fishing in early 1987, the Mute Swan *(Cygnus olor)* population appeared to respond rapidly and the National Waterfowl Count (NWC) index for the species increased markedly in the winters of 1987/88, 1988/89 and 1989/90 (Salmon, Prys-Jones & Kirby 1988, 1989; Kirby, Waters & Prys-Jones 1990). The British population was relatively stable from the mid *1950s* to 1986/87 (Owen, Atkinson-Willes & Salmon 1986, Kirby, Delany & Quinn in press), but this apparent overall stability masked considerable population declines in some regions and increases in others. Changes at a regional level have been revealed by successive national breeding season surveys in 1955/56, 1961, 1978 and 1983 (Rawc1iffe 1958, Campbell 1960, Eltringham 1963, Ogilvie 1981, Brown & Brown 1984b, Ogilvie 1986) and by analysis of long-term trends in regional abundance using winter count data (Kirby, *et al.* in press). There have also been detailed regional studies of declines in the valleys of the Trent (Coleman, Minton & Coleman 1991), the Warwickshire Avon (Hardman & Cooper 1980) and the Thames *(eg* Birkhead & Perrins 1985) and of a steady increase between 1977 and 1982 in the Lothians (Brown & Brown 1984a).

Boyd & Ogilvie (1964) and Ogilvie (1967) demonstrated that hard winters can result in considerable Mute Swan mortality and, in the late *1970s* and early *1980s,* the impact on swan numbers of lead poisoning caused by the ingestion of anglers' fishing weights came to be realised (Simpson, Hunt & French 1979, Goode 1981, Birkhead 1982, Birkhead 1983, Birkhead & Perrins 1985). Comparison of the annual population indices obtained from NWC data for the Mute Swan with indices for three species with broadly similar habitat requirements (Great Crested Grebe, Canada Goose and Tufted Duck) showed that the Mute Swan was exceptional in not having experienced a considerable increase in population since 1955 (Ogilvie 1986). Following the apparent success of the ban on lead weights, as reflected by the marked increase in the Mute Swan population in 1988 and 1989, the then Nature Conservancy Council (NCC) asked The Wildfowl & Wetlands Trust (WWT), the British Trust for Ornithology (BTO) and the Scottish Ornithologists' Club (SOC) to undertake a national Mute Swan survey during the 1990 breeding season with the following objectives: a) to assess population changes since the 1983 census and describe their geographical pattern, particularly in relation to the ban on the use of lead weights by anglers; b) to estimate the current sizes of local and national populations; and c) to provide a baseline for future monitoring of the species.

This report addresses objectives b) and c) only, since the data from the 1978 and 1983 surveys are not yet ready for analysis. Even in respect of objectives b) and c), the findings must be regarded as provisional since full statistical tests have yet to be made. This report provides a description of the distribution and abundance of breeding and non-breeding Mute Swans during 1990, with the results being presented in both tabular and map form. Preliminary examination of the habitat data collected and a discussion of factors affecting Mute Swan populations are also included. Further, more detailed, analyses including comparison with earlier surveys will be undertaken in due course.

METHODS

Previous Surveys

The Mute Swan is perhaps one of the easiest common bird species in Britain to census and it appears possible to obtain reasonably accurate estimates of both non-breeding and breeding elements of the population. Previous surveys have relied on the excellent networks of regional representatives and their fieldworkers maintained by the BTO and SOC to conduct their counts and enquiries. The 1955/56 survey was one of the first of any species to use l0km squares in the presentation of results. The census in 1961 was only partial, covering selected areas of Britain from the air, these counts being verified by ground cover of certain counties. The 1978 survey was the first "modem" census and the fieldwork technique proved so satisfactory that it was hardly changed in 1983 and 1990. In all surveys to date, the major problem has been the impossibility of obtaining 100% coverage of many regions, making it necessary to adjust population estimates by extrapolating from areas with good coverage. The coverage achieved in 1990 was the most comprehensive yet.

Planning and methodology

The scope and methodology of the 1990 survey were decided at two meetings between representatives from the WWT and BTO. At the first meeting in September 1989 it was agreed to adopt the fieldwork techniques used in the 1978 and 1983 surveys, comprising separate censuses of territorial and of non-breeding Mute Swans in April and May. The possibility of the final season of the BTO's Atlas fieldwork being adversely affected by the swan survey was discussed and, for this reason, it was decided not to conduct the survey in Ireland in 1990. The final design of the survey was decided at a meeting in December 1989 attended by NCC and other experts as well as the WWT and BTO. A key element in methodology was securing a sound basis for the extrapolation of population totals in the event of gaps in coverage. It was suggested that previous surveys had involved non-random sampling of squares, giving rise to bias in estimating total populations. Despite reservations as to the practicality of achieving the desired result, it was agreed to provide each Regional Organiser with a list of the 10km squares in his or her region in random order with instructions to cover them in that order if complete coverage were impossible. To make this easier, it was decided that in the event of a square's being only partly covered, it would be permissible for observers to provide a "best estimate" for the remaining part. Estimates were also to be provided for squares where it was not possible to organise coverage. In addition, squares known by Regional Organisers never to have held swans because they contain no suitable habitat could be submitted as "probable blanks" without being visited.

Fieldwork techniques in 1990

Swan counters used virtually identical techniques and recording forms in 1990 to those employed for the surveys of 1978 and 1983. The organiser for each BTO region allocated as many 10km squares as possible in his or her region to volunteer counters, who were instructed to visit all wetland habitat suitable for Mute Swans in their squares between 1 April and 31 May 1990. For each square two simple forms were to be completed, one for territorial birds and

one for non-breeders, on which details of localities, dates and numbers of birds present were entered. For territorial birds the total was broken down according to the breeding status of each pair, whether merely holding territory, at a nest, with cygnets or failed breeders. On the reverse of each form a grid was provided showing the 1 km squares within the 10km square and the recorder, using simple codes, marked the positions of all birds or nests found. Completed paperwork was returned to the Regional Organiser, who filled out a Regional Summary Sheet, including estimates for squares that were not covered, before sending his or her results to Slimbridge. Examples of the data forms and instructions sent to Regional Organisers are provided in Appendix 1.

Regional Organisers

Because 1990 was the final year of fieldwork for the BTO's "New Atlas of Breeding Birds in Britain and Ireland" and there were fears that the Mute Swan survey would divert observers from Atlas fieldwork, the BTO approached its Regional Organisers in October 1989 to assess their enthusiasm for a Mute Swan survey. The majority (78%) agreed to act as local organisers for the survey and organisers for the remaining regions were quickly found, many of the WWT's NWC organisers taking on this role. To ensure his involvement at every level of the survey, *S.D.* acted as Regional Organiser for Gloucestershire, and also covered nine squares spread between Devon, Somerset, Wiltshire, Oxfordshire, Gloucestershire and Brecon; J.J.D.G. covered a square in Buckinghamshire.

Central Organisation

In Scotland Allan and Lyndesay Brown kindly agreed to act as organisers (as they had done in 1983) after discussion at the SOC conference in November 1989, and in England and Wales the survey was co-ordinated by *S.D.* and J.J.D.G. Three thousand six hundred copies each of data forms and instructions were distributed to the 72 English, 15 Welsh and 28 Scottish regions in January 1990. Regional summary sheets, listing the randomised 10km squares in each region, were produced for each organiser to summarise his or her counts and estimates. A press release, articles in wildlife magazines and several radio and TV interviews produced many hundreds of offers of help from the general public. These were sent to the relevant regional organiser and replied to with an information and publicity leaflet about the Mute Swan and the survey. During February and March 1990 most of the regional organisers were telephoned for discussion of the survey in their area and, by the start of fieldwork in April, there were grounds for cautious optimism about the level of coverage to be expected. Once the survey started in April, further media coverage raised public interest to a very high level and a new data form for "casual observations" was produced.

Return of data

By October 1990 the Scottish organisers had received counts from 36% of their regions and 75% of data had been received for England and Wales. Overdue counts continued to arrive over the winter of 1990/91 and, by May 1991, a year after the end of the survey, it was clear that no information had been obtained by three of the organisers in England and Wales. The Scottish data arrived at Slimbridge at this time, minus counts from four regions, and entry onto a computer database and subsequent checking proceeded until August 1991. This was when the extent of work necessary on the databases from 1978 and 1983 became apparent and checking and

amendment of these from the original data forms and summary sheets was still not complete in December 1991.

Data processing

Processing of data for territorial and breeding birds was straightforward, since each record was of a single pair, and pairs remain relatively sedentary during April and May. Processing of non-breeding data was more complicated, since duplication of counts is to be expected because non-breeders are more mobile, and because failed breeders may join non-breeding flocks and be counted twice. To reduce such duplication, which to some extent is offset by birds being missed because of their mobility, the analysis was restricted to counts made between 25 March and 15 May 1990 and, where multiple counts were made at a site during this period, to the count closest to 15 April.

RESULTS

Coverage

The boundaries of the BTO regions used in the presentation of these results are shown in Appendix 2, whilst the extent of coverage achieved is shown in Figure 1. Overall, 85% of l0km squares in Britain received coverage or were considered to comprise habitat unsuitable for Mute Swans. Areas with high concentrations of the species can take considerable effort to cover, and for this and other reasons counts were not made in Benbecula and the Uists, Aberdeenshire, parts of the artificially drained regions of Huntingdonshire, Cambridge and Lincolnshire, and sections of the Somerset Moors and Levels. Because a disproportionately high number of such densely populated squares were not covered, the proportion of the final population totals appearing in Table 1 that were estimated is higher than the proportion of the country that such squares comprise. Further squares were not covered because the habitat was unsuitable (in which case they were treated as "probable blanks") because they were remote, and for a variety of personal reasons. The attempt to obtain coverage of squares in random order in incompletely covered regions was a failure; fortunately, overall coverage was so good that this was only a problem in a few regions, so that the subjective estimates made for these only comprise a small proportion of the results.

In Scotland coverage was obtained or habitat was considered unsuitable in 81 % of 10km squares. No information was received from two regions (Aberdeenshire, and Kincardine and Deeside) and incomplete data were received from Argyll and from Benbecula and the Uists, but not in time for inclusion in this report. Nearly all suitable habitat in every other region was covered and further information may yet be forthcoming from some of the regions mentioned above.

In Wales, three out of 15 regions were not covered, but it was possible to obtain full details from two (Mid and South Glamorgan) retrospectively thanks to the meticulous record keeping of a local nature reserve warden and the county bird recorder. The rest of the principality received 100% coverage (or comprised unsuitable habitat) except for Clwyd East, which was not covered, and Caernarfon where 84% coverage was achieved.

England received coverage, or habitat was considered unsuitable, in 90% of 10km squares overall, and only from one region (Huntingdonshire) were data not submitted by the Regional Organiser. Fortunately, one active counter in Huntingdonshire submitted records from four of the 14 10kIn squares direct to the national organiser. Other regions in England which were relatively poorly covered (50% or less) were Essex South, Norfolk South-west, Rugby, York, and North Humberside. A further ten regions received coverage in 50 - 90% of squares, eight received 90 - 99% and 46 received 100% coverage.

Mute Swan Totals

Abundance bv BTO Region

Table 1 gives the population of Mute Swans in Britain in Spring 1990, summarised by BTO Region and breeding status. Estimates made to allow for gaps in coverage are also shown. The total population was estimated at 25,748 birds of which 7946 (3973 pairs) were recorded breeding (with nest or young) and a further 2330 (1165 pairs) were holding territory but with no sign of nest or young. Just 12.5% of the overall total (20% of the breeding total) comprise subjective (but carefully considered) estimates made for areas that were not covered, usually by the Regional Organiser. The overall non-breeding population total was 15,422 of which 1840 were estimated. On this basis, 31 % of the population comprised breeding birds, a further 9% held territory without being recorded breeding, and 60% were non-breeders.

Abundance bv l0km square

Squares with high densities of Mute Swans

Tables 2 & 3 give details of all squares where more than 20 pairs or more than 100 non--breeding Mute Swans were recorded during the survey period. Although they account for a very small proportion of the l0km squares in Britain (0.16%), the 41 squares appearing on the two tables held 17% of paired and 29% of non-breeding birds. Figures 2 & 3 show the abundance of breeding and non-breeding Mute Swans in Britain in 1990 by 10km square and, in conjunction with the tables, provide a detailed summary of the current status and distribution of Britain's summering Mute Swan population.

For probably the first time, the most densely populated 10km square recorded in Britain was not SY58, which contains the artificially maintained colony at Abbotsbury in Dorset. Abbotsbury, with 102 nesting pairs and 300 non-breeders (504 birds), was exceeded by the Loch of Harray and the contiguous Loch of Stenness on Orkney, most of which fall within HY21, where 140 pairs and 382 non-breeders (662 birds) were recorded. An additional 20 pairs were found on the parts of these lochs that fall within HY31, so that more than 700 Mute Swans were present on the two lochs. Many pairs on the Loch of Harray have abandoned the territorial habit and nest colonially, this being the only site where such behaviour has been recorded in Britain under natural conditions. The square with the third highest breeding density was TG40 in south-east Norfolk:, which contains Halvergate Marshes RSPB reserve. Here, the warden counted a total of 45 territorial and breeding pairs and estimated that a further 15 pairs were present in areas which could not be covered. There were, in addition, 50 non-breeding birds present in this square.

One of the most important areas in Britain for Mute Swans is the valley of the Avon and its tributary, the Wylye, in Wiltshire, Hampshire and Dorset. Here six adjacent squares produced a total of 188 territorial and breeding pairs and 1052 non-breeders, or about 3.7% of the British paired population and 6.8% of the non-breeders.

Apart from the two introduced and almost self-contained populations in the Orkneys and the Outer Hebrides, there were few dense concentrations of breeding Mute Swans north of the Fens or west of the Somerset Levels. Exceptions to this, holding 26 and 24 pairs respectively, were NT84 in the valley of the Tweed (Borders district), and SE42 at the Fairburn Ings RSPB reserve in Yorkshire. Two further squares in the Tweed valley held more than 12 pairs of territorial or breeding birds, as did ND25 (Loch Watten) in Caithness, SE74 in the Lower Derwent Valley of south-east Yorkshire, and SK22 on the Trent in east Staffordshire near Burton.

In southern and eastern England squares with more than 12 pairs of territorial or breeding Mute Swans tend to be close to those with higher densities: in the Fens, eastern and southern East Anglia, the coastal marshes and adjacent rivers of Kent and Sussex, six squares along the Thames valley, and single ones along the valley of the Lea in Hertfordshire, the Frome in Dorset, the upper Avon in Hampshire and on the Somerset Levels.

Table 3 illustrates that non-breeders were usually also found at high density in squares with large numbers of paired birds. Three squares in Norfolk: and Suffolk: and five in Kent and Sussex held more than 20 pairs but fewer than 100 non-breeders. Conversely, 11 squares held very high concentrations of non-breeders, but were less important for breeding and territorial birds. Flocks on the Thames accounted for three of these squares, the others being in the Fens, the Aide estuary, the Arun Valley and Chichester Harbour in Sussex, the Somerset Levels, and Slimbridge and the Cotswold Water Park in Gloucestershire and Wiltshire.

Squares with moderate and low densities of Mute Swans

These high concentrations of birds are only found over a small proportion of the range of the species in Britain, with much lower densities being more usual. A total of 1630 squares (58%) were unoccupied by paired Mute Swans, and 1955 (70%) by non-breeders. These figures are slightly inflated by the fact that estimates to compensate for lack of coverage in Scotland were made at the regional, not the 10km square level, so that all squares in these four regions appear as blanks. The figures also slightly over-represent the true land area of Britain, because no compensation is made for 10km squares on the coast which may contain very small amounts of land. The likelihood of these coastal squares holding Mute Swans is also reduced.

Figures 2(a) and 3(a) show that the distribution of unoccupied squares was closely related to altitude and terrain, with large upland blocks of Scotland, Wales, northern and south-western England being devoid of swans. In southern and eastern England, Mute Swans are only absent from dry, elevated or heavily wooded areas, often geologically associated with chalk, such as the Chilterns, central East Anglia, the New Forest and the downlands of Dorset, Hampshire, Wiltshire, Berkshire, Sussex and Kent.

Figure 4 summarises the frequency distribution of abundance of paired Mute Swans by 10km square. Territorial and breeding birds are thinly distributed over a majority of the range: a total of 368 squares held only one pair of birds and a further 240 squares held two pairs, so that 52%

of occupied squares held just one or two pairs. Raising the threshold to four pairs increases the proportion of occupied squares to 74%. This effect is clear from Figure 2 where the reduction in squares occupied by three or more pairs (Figure 2(b» is marked when compared with the number of squares with one or more pairs (Figure 2(a». Figures 2(c) & 2(d) clearly show that moderate densities of paired birds occur in l0km squares adjacent to those with high densities described in the previous section.

The frequency distribution of abundance of non-breeding birds reveals a similar pattern (Figure 5). A total of 108 squares held single birds recorded as non-breeders. Since non-breeding Mute Swans are normally gregarious, it seems likely that a proportion of these were bereaved territorial birds, and some could in fact have been breeding pairs of which the pen was sitting on a nest out of sight of the observer. Similarly, records of two non-breeders in a square may on occasion have referred to territorial pairs or failed breeders. Once again low densities of birds occurred most frequently, and the idea that large flocks of non-breeding Mute Swans are the norm would appear to be a misconception, at least in the breeding season. The higher numbers of non-breeders than paired birds, and their more gregarious habits, were reflected by relatively large numbers of squares holding higher densities of birds. Non-breeders were, however, more scattered in their overall distribution. This can be seen clearly by comparing Figures 3(a) and 2(a): territorial birds appear to be able to exclude non-breeders from habitat that will not support both.

DISCUSSION

Table 4 provides a comparison of population totals of Mute Swans derived from all national breeding season surveys undertaken to date. Eltringham's 1961 survey is excluded because it was only partial. The Mute Swan population in Britain has increased considerably since previous surveys and appears now to stand at the highest level yet recorded. Given the incomplete coverage and possibly unsound extrapolations in earlier surveys, however, this conclusion must remain tentative until formal analyses are complete.

The increases in numbers and in breeding success on the Thames have been positively linked to a decline in exposure to anglers' lead weights (Sears 1988) and Sears & Hunt (1991), using post-mortem data, have described a decline in the incidence of lead poisoning in Mute Swans from throughout England from 50% in 1980/81 to 30% in 1987/88. Over the same period the incidence of lead poisoning in swans rescued from the Thames valley declined from 56% to 15%, and median blood lead levels of immature Mute Swans in the Windsor flock declined from 107 pg/l00ml to 25pg/100ml. It would appear that in parts of England the reduction in exposure of swans to lead since the ban on the sale of most sizes of fishing weight in 1987 has played a major role in the recovery of their populations. Lead poisoning still occurs in many areas but, as anglers use up their· stockpiles, and as lead discarded in the past becomes more deeply buried in sediment, continuing reductions in the number of lead poisoning incidents can be expected.

A little-documented factor having a positive effect on Mute Swan populations in many areas is the number of swan hospitals, often run by professional veterinarians, which have come into being, especially since the extent of the lead poisoning problem was realised in the 1970s. Squares TQ06 and TQ07 in Surrey and London/Middlesex (see Tables 2 & 3) are on the Thames in an area where large numbers of swans from one of the biggest of these hospitals,

("Swan Lifeline") are rehabilitated. There are probably as many as 50 swan hospitals in existence (E.Rees, pers. comm.) and their combined effect on Britain's Mute Swan population may be important.

Another important factor affecting Mute Swan populations is winter weather. It has long been known that severe weather causes increased winter mortality of Mute Swans (Boyd & Ogilvie 1964, Ogilvie 1967) and Esselink & Beekman (1991) have shown that mild winters are not only associated with low mortality but are also followed by high reproductive output. Figure 6 shows the mean difference of January and February air temperatures from the 1951 1980 mean figures for those months for all weather stations in Scotland and in England and Wales (Meteorological Office data). The plot shows that there is little or no difference in the trends for the two regions compared, and that January and February of 1988 - 1990, the three years following the ban on the sale of lead weights, were exceptionally mild. Three mild winters in succession will undoubtedly have contributed to the increase in Britain's Mute Swan population at the end of the 1980s.

Lead poisoning from anglers' weights was not identified as a cause of mortality of Mute Swans in Scotland, and lead for fishing was in any case not banned there, yet there have apparently been even more marked increases in the Mute Swan population north of the border than in England and Wales. A possibility is that increased sowing of winter cereals in Scotland has improved the winter food supply for swans, enabling a higher proportion of birds to survive the winter. In a few districts swans are actually provided with food by landowners to reduce losses of winter cereals and rape caused by trampling (R. Goater pers. comm., J.J.D.G., pers. obs.). Scottish birds, at least those on the east coast, also appear to be more mobile than they are over much of their range (A. Brown and A. Bramhall, pers. comm.) and it seems possible that a proportion of the increase could originate from immigration. Equally, it is possible that none of these factors has been important and that the whole of the increase has resulted from the mild winters.

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Table 1. 1990 Mute Swan totals (provisional)

BTO Region number (see Appendix 2)	Recording region		Pairs with nests/broods	Additional estimated pairs	Territorial only pairs	Non-breeding birds	Additional estimated non-breeders	Regional total
1	Aberdeen		-	100	-	-	150	350
2	Angus		24	-	4	32	100	188
3	Argyll north & Mull		13	20	5	34	30	140
4	Argyll south & Gigha		8	-	2	23	-	43
5	Arran Bute & Cumbrae		0	-	0	8	-	8
6	Ayrshire		35	-	4	83	-	161
7	Benbecula & The Uists		-	130	-	-	450	710
8	Borders		58	9	49	354	20	606
9	Caithness		23	3	9	92	7	169
10	Central		13	3	2	70	6	112
11	Dumfries		32	-	6	72	-	148
12	Fife & Kinross		30	-	9	80	-	158
13	Inverness (E&Speyside)		7	3	12	36	6	86
14	Inverness west		4	1	0	1	4	15
15	Islay Jura & Colonsay		8	-	4	21	-	45
16	Kincardine & Deeside		-	3	-	-	6	12
17	Kirkudbright		23	-	5	128	-	184
18	Lanark R'frew D'barton		64	3	20	182	10	366
19	Lewis & Harris		0	-	0	0	-	0
20	Lothians		46	-	10	175	-	287
21	Moray		16	-	3	17	20	75
22	Orkney		163	-	16	454	-	812
23	Perth		25	-	4	117	-	175
24	Rum Eigg Canna & Muck		0	-	0	0	-	0
25	Ross		41	-	16	155	4	273
26	Shetland		0	-	0	1	-	1
27	Skye		0	-	0	0	-	0
28	Sutherland		4	2	0	3	4	19
29	Wigtown		13	-	6	26	-	64
TOTAL SCOTLAND		**Pairs**	**650**	**277**	**186**			
		Birds	**1,300**	**554**	**372**	**2,164**	**817**	**5,207**

Table 1. continued

BTO Region number (see Appendix 2)	Recording region	Pairs with nests/broods	Additional estimated pairs	Territorial only pairs	Non-breeding birds	Additional estimated non-breeders	Regional total
30	Avon	19	-	6	55	4	109
31	Bedfordshire	32	1	6	172	-	250
32	Berkshire	32	5	9	377	27	496
33	Buckinghamshire north	25	7	10	184	11	279
34	Buckinghamshire south	19	-	8	124	5	183
35	Cambridgeshire	73	10	49	417	20	701
36	Cheshire	87	-	7	162	-	250
37	Cleveland	4	-	2	5	-	17
38	Cornwall	24	9	13	95	40	227
39	Cumbria north	19	-	3	65	-	109
40	Cumbria south	41	-	12	145	-	251
41	Derbyshire	4	28	2	14	21	103
42	Devon	55	6	22	254	9	429
43	Dorset	217	3	36	775	-	1,287
44	Durham	3	1	2	11	-	23
45	Essex northeast	68	-	35	224	-	430
46	Essex northwest	15	-	4	12	-	50
47	Essex south	9	6	4	9	8	55
48	Gloucestershire	52	2	8	143	2	269
49	Greater Manchester	21	-	1	70	8	122
50	Hampshire	125	-	58	894	-	1,260
51	Hereford	28	5	17	104	20	224
52	Hertfordshire	68	1	13	161	-	325
53	Huntingdonshire	13	71	1	284	97	551
54	Isle of Man	4	-	0	24	-	32
55	Isle of Wight	11	-	1	28	-	52
56	Kent	152	8	72	425	45	934
57	Lancashire east	7	-	0	7	-	21
58	Lancashire northwest	20	-	6	30	-	82
59	Lancashire south	12	-	0	48	-	72
60	Leicestershire/Rutland	68	-	9	232	-	386
61	Lincolnshire east	17	-	14	46	1	109
62	Lincolnshire north	15	9	9	44	19	129
63	Lincolnshire south	25	-	15	90	-	170
64	Lincolnshire west	26	12	17	181	14	305
65	London/Middlesex	58	5	21	275	2	445
66	Merseyside	3	-	0	24	2	32
67	Norfolk northeast	37	3	30	225	4	369
68	Norfolk northwest	27	7	11	64	10	164
69	Norfolk southeast	82	17	39	299	25	600
70	Norfolk southwest	5	27	2	8	63	139
71	Northamptonshire	30	9	16	194	10	314
72	Northumberland	53	-	22	136	-	286
73	Nottinghamshire	55	-	12	185	-	319
74	Oxfordshire north	15	-	4	36	-	74
75	Oxfordshire south	86	-	20	428	-	640
76	Rugby	3	8	0	0	14	36
77	Scilly	1	-	0	5	-	7
78	Shropshire	52	2	21	138	5	293
79	Somerset	20	47	27	249	248	685
80	Staffordshire north	45	-	12	67	-	181
81	Staffordshire south	47	-	16	30	-	156

Table 1. continued

BTO Region number (see Appendix 2)	Recording region		Pairs with nests/broods	Additional estimated pairs	Territorial only pairs	Non-breeding birds	Additional estimated non-breeders	Regional total
82	Suffolk		56	15	42	396	103	725
83	Surrey		51	-	18	215	-	353
84	Sussex		166	5	46	676	-	1,110
85	West Midlands		32	2	3	90	-	164
86	Warwickshire		14	6	16	76	2	150
87	Wiltshire east		92	-	34	596	-	848
88	Wiltshire west		54	10	14	190	4	350
89	Wirral		3	1	1	35	-	45
90	Worcestershire		30	-	7	139	14	227
91	Yorkshire (York)		14	14	2	10	25	95
92	Yorkshire (Bradford)		8	-	0	11	-	27
93	Yorkshire east		14	-	2	23	-	55
94	Yorkshire (Harrogate)		3	3	1	16	3	33
95	Yorkshire (Leeds)		27	-	10	172	-	246
96	Yorkshire north		5	1	4	1	-	21
97	Yorkshire northeast		1	-	3	4	-	12
98	Yorkshire (NHumberside)		4	27	1	19	46	129
99	Yorkshire northwest		1	-	3	1	-	9
100	Yorkshire southeast		6	-	3	39	-	57
101	Yorkshire southwest		5	-	0	3	-	13
TOTAL ENGLAND		**Pairs**	**2,565**	**393**	**934**			
		Birds	**5,130**	**786**	**1,868**	**10,986**	**931**	**19,701**
102	Anglesey		8	-	4	20	-	44
103	Brecon		7	-	7	56	-	84
104	Caernarvon		2	4	1	31	26	71
105	Cardigan		4	-	1	0	1	11
106	Carmarthen		8	-	5	9	-	35
107	Clwyd west		4	-	0	25	-	33
108	Clwyd east		-	13	-	-	65	91
109	Glamorgan mid & south		7	-	0	56	-	70
110	Glamorgan west		8	-	1	5	-	23
111	Gwent		17	-	9	78	-	130
112	Merioneth		7	-	0	49	-	63
113	Montgomery		12	1	8	21	-	63
114	Pembrokeshire		10	-	2	51	-	75
115	Radnor		1	-	7	31	-	47
TOTAL WALES		**Pairs**	**95**	**18**	**45**			
		Birds	**190**	**36**	**90**	**432**	**92**	**840**
TOTAL OVERALL		**Pairs**	**3,310**	**663**	**1,165**			
		Birds	**6,620**	**1,376**	**2,330**	**13,582**	**1,840**	**25,748**

Table 2. 10km squares with more than 20 pairs of Mute Swans 25 March - 15 May 1990

Square	No of pairs	BTO Region	Principal sites
HY21	140	Orkney	Loch of Harray, Loch of Stenness
SY58	102	Dorset	Abbotsbury
TG40	60	Norfolk SE	Halvergate Marshes
SZ19	38	Dorset	River Avon
SU11	37	Hampshire	River Avon
SU13	31	Wiltshire E	River Avon
SU12	31	Wiltshire E	River Avon
TL91	28	Essex SE	Abberton Reservoir
SU10	27	Hampshire	River Avon
TQ07	27	London	River Thames & associated gravel pits
NT84	26	Borders	River Tweed
TL48	26	Cambridge	Ouse Washes
TR02	26	Kent	Romney/Denge Marshes
TR26	25	Kent	River Stour & Wantsum Marshes
SE42	24	Yorks Leeds	Fairburn Ings
SU03	24	Wiltshire W	River Avon, River Wylye
TG30	24	Norfolk SE	Claxton Marsh/Strumpshaw
TQ92	24	Kent	East Guldford Level
TQ77	23	Kent	Higham/Cliffe Marshes
TM03	23	Essex/Suffolk	Rivers Stour & Brett
TM49	21	Norfolk SE	Waveney Valley Marshes
TQ06	21	Surrey	River Thames, Walton-Staines
HY31	20	Orkney	Loch of Harray, Loch of Stenness
TQ60	20	Sussex	Pevensey Levels

N.B. Areas that were not covered that may have appeared on this table include squares in the Outer Hebrides, the Somerset Moors and Levels, Huntingdonshire and Lincolnshire.

Table 3. 10km Squares with more than 100 non-breeding Mute Swans 25 March - 15 May 1990

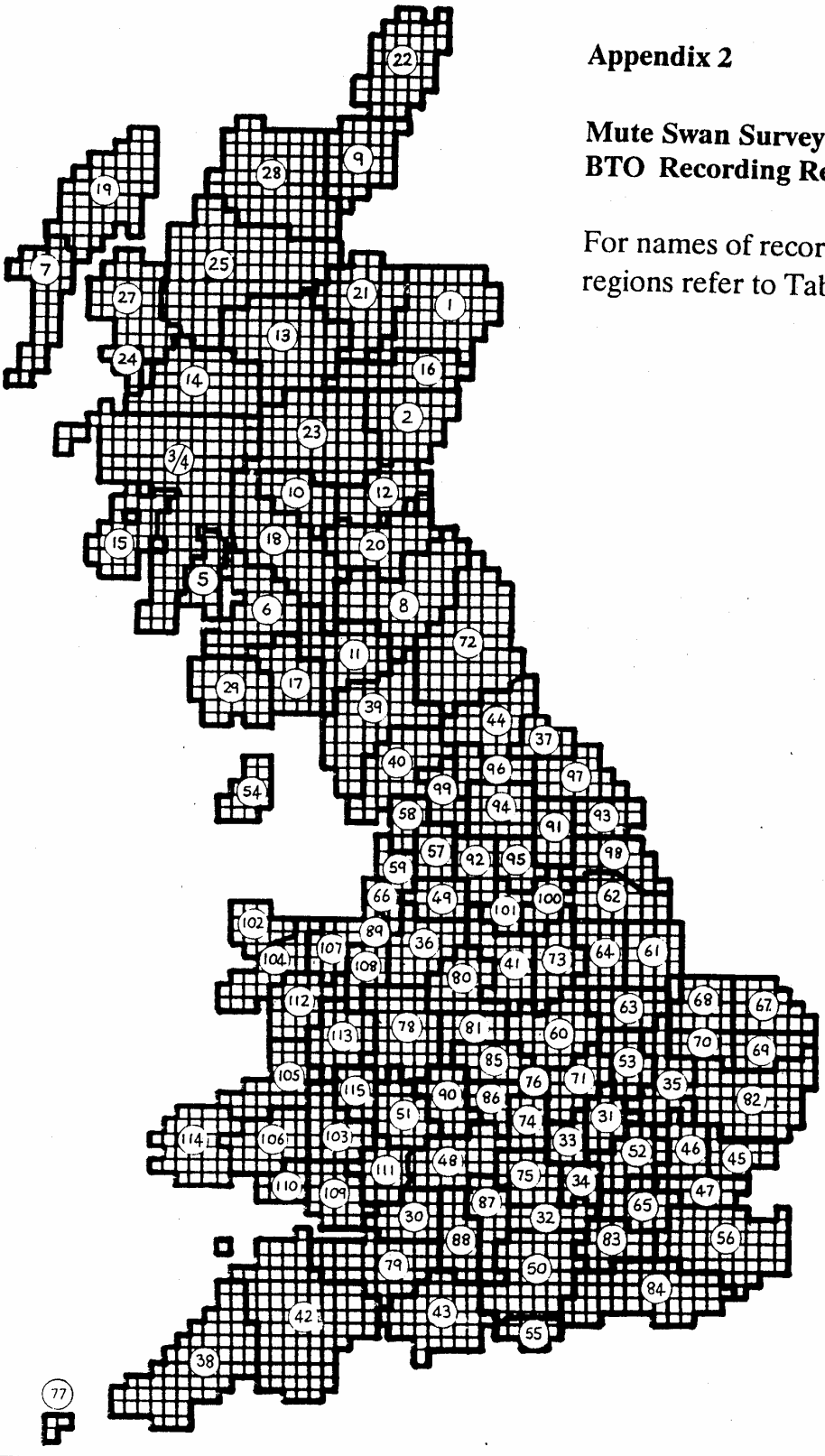
Square	No of birds	BTO Region	Principal sites
HY21	382	Orkney	Loch of Harray, Loch of Stenness
SY58	300	Dorset	Abbotsbury
SU11	288	Hampshire	River Avon
NT95	268	Borders	River Tweed
TL37	246	Huntingdonshire	Barleycraft Gravel Pit
SU12	197	Wiltshire E	River Avon
SU10	195	Hampshire	River Avon
TL91	187	Essex NE	Abberton Reservoir
SZ19	176	Dorset	Christchurch Harbour
NT73	163	Borders	River Tweed
SU97	150	Berkshire	River Thames, Windsor
TM13	150	Suffolk	Stour Estuary, Manningtree
TL48	129	Cambridge	Ouse Washes
SU03	125	Wiltshire W	River Avon, River Wylye
TM02	125	Essex NE	River Colne
TQ01	120	Sussex	Arun Valley
TL47	119	Cambridge	Ouse Washes
SE42	117	Yorkshire Leeds	Fairburn Ings
TQ07	116	London	River Thames & associated gravel pits
SU09	114	Wiltshire E	Cotswold Water Park West
SP86	114	Northamptonshire	River Nene & associated gravel pits
ST44	111	Somerset	Tealham & Westhay Moors
SO70	109	Gloucestershire	WWT Slimbridge, Frampton Gravel Pits
TM45	108	Suffolk	Aldeburgh & associated marshes
SU80	105	Sussex	Chichester Harbour
SU77	104	Berkshire	River Thames, Reading
SU29	103	Oxfordshire S	River Thames, Lechlade
TQ16	101	Surrey	River Thames, Surbiton

N.B. Areas that were not covered that may have appeared in this table include squares in the Outer Hebrides, the Somerset Moors and Levels, Huntingdonshire and Lincolnshire.

Table 4. Mute Swan population estimates from four British breeding season surveys

	1955/56	1978	1983	1990
England	15,600-17,300	13,340 -19%	14,800 +11%	*20,000 +35%
Scotland	3,500-4,000	3,680 -2%	3,250 -12%	*4,900 +51%
Wales	780	590 -24%	700 +19%	840 +20%
Total Britain	19,900-21,600	17,600 -15%	18,750 +7%	25,750 +37%

*300 birds on the Tweed (Borders District) subtracted from Scotland total and added to England for comparability with other surveys.

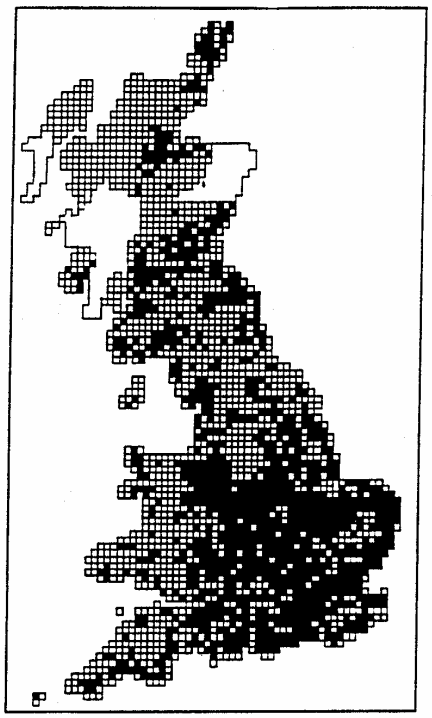


Appendix 2

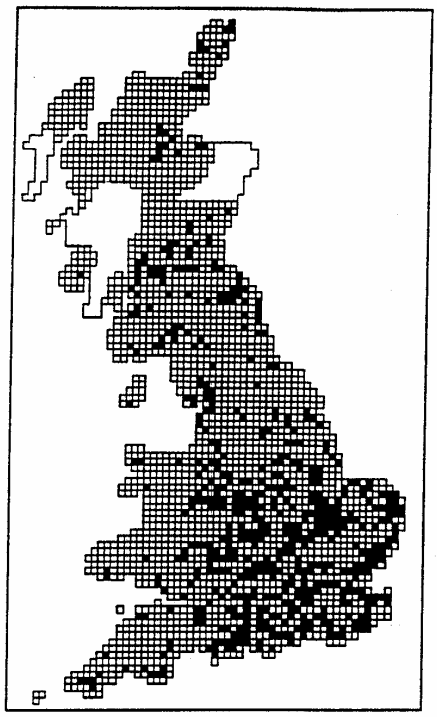
Mute Swan Survey 1990
BTO Recording Regions

For names of recording regions refer to Table 1

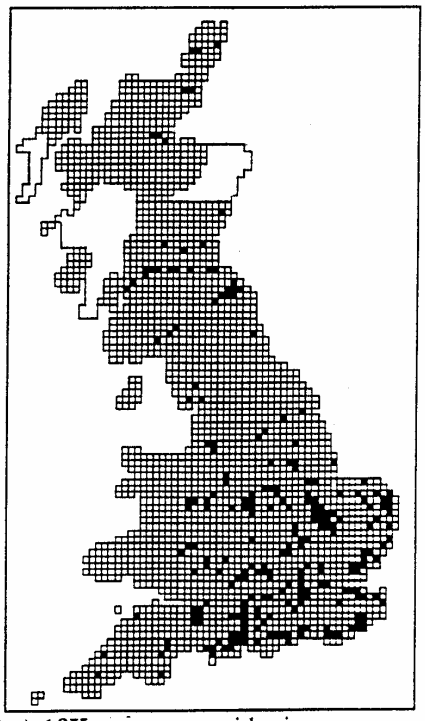
Figure 2. Distribution of paired Mute Swans in spring 1990



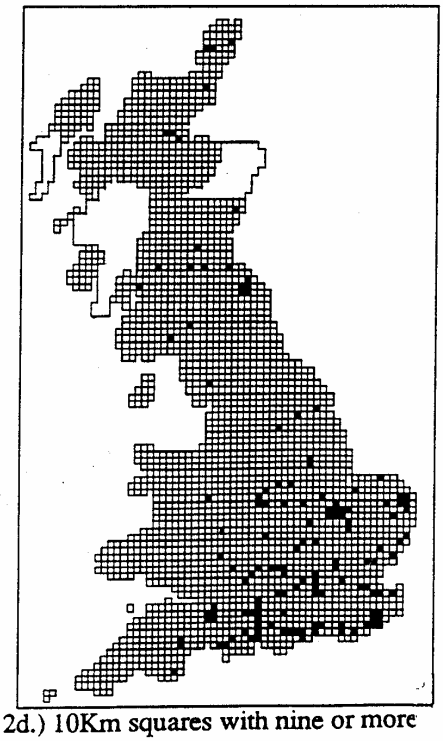
2a.) 10Km squares with one or more pairs of Mute Swans



2b.) 10Km squares with three or more pairs of Mute Swans

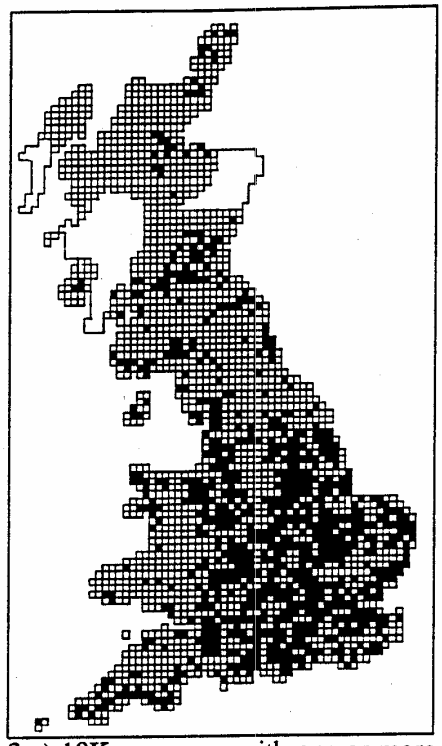


2c.) 10Km squares with six or more pairs of Mute Swans

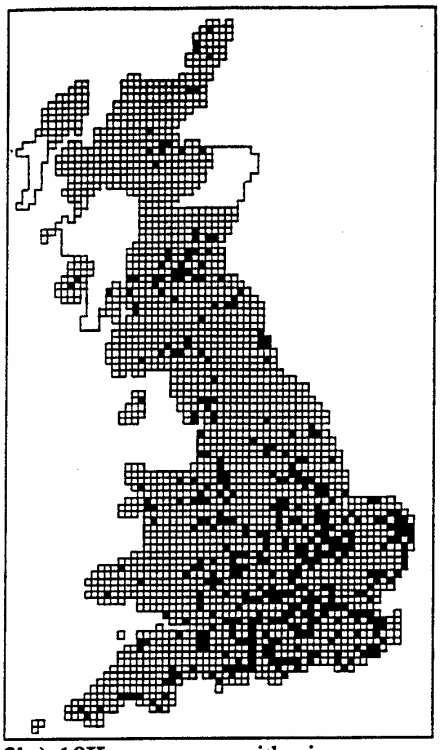


2d.) 10Km squares with nine or more pairs of Mute Swans

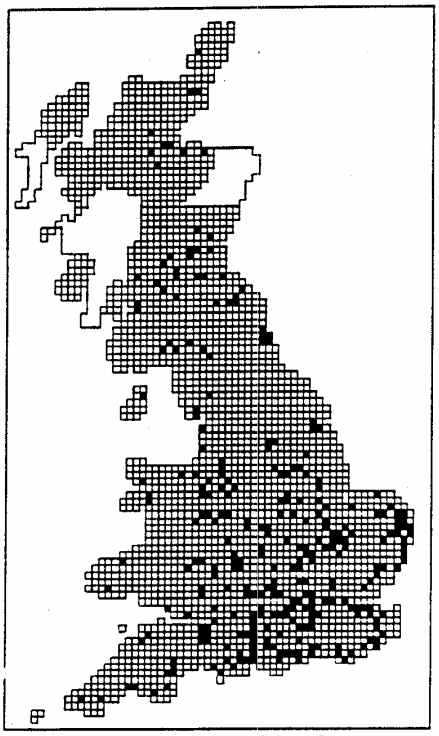
Figure 3. Distribution of Non-breeding Mute Swans in spring 1990



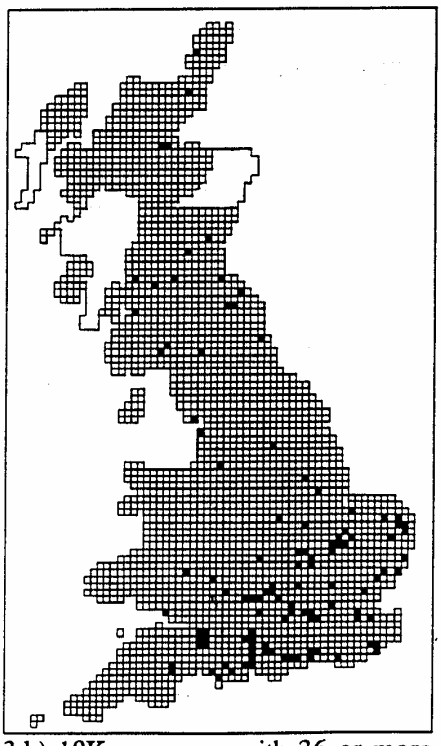
3a.) 10Km squares with one or more non-breeding Mute Swans (one bird in Shetland has been omitted)



3b.) 10Km squares with six or more non-breeding Mute Swans



3c.) 10Km squares with 12 or more non-breeding Mute Swans



3d.) 10Km squares with 36 or more non-breeding Mute Swans

Figure 4. Frequency distribution of Mute Swan abundance by 10km square – Breeding & territorial pairs

Only squares with fewer than 20 pairs are shown. For squares with >20 pairs see Table 2.

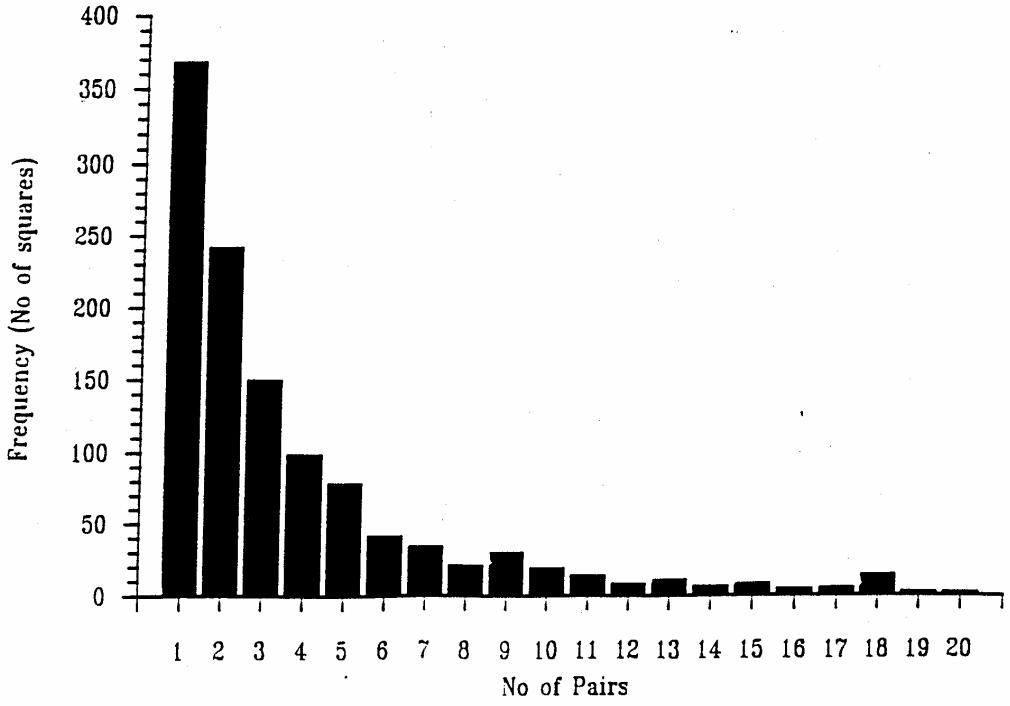


Figure 5. Frequency distribution of Mute Swan abundance by 10km square – Non-breeders

Only squares with <100 individuals shown. For squares with >100 individuals see Table 3.

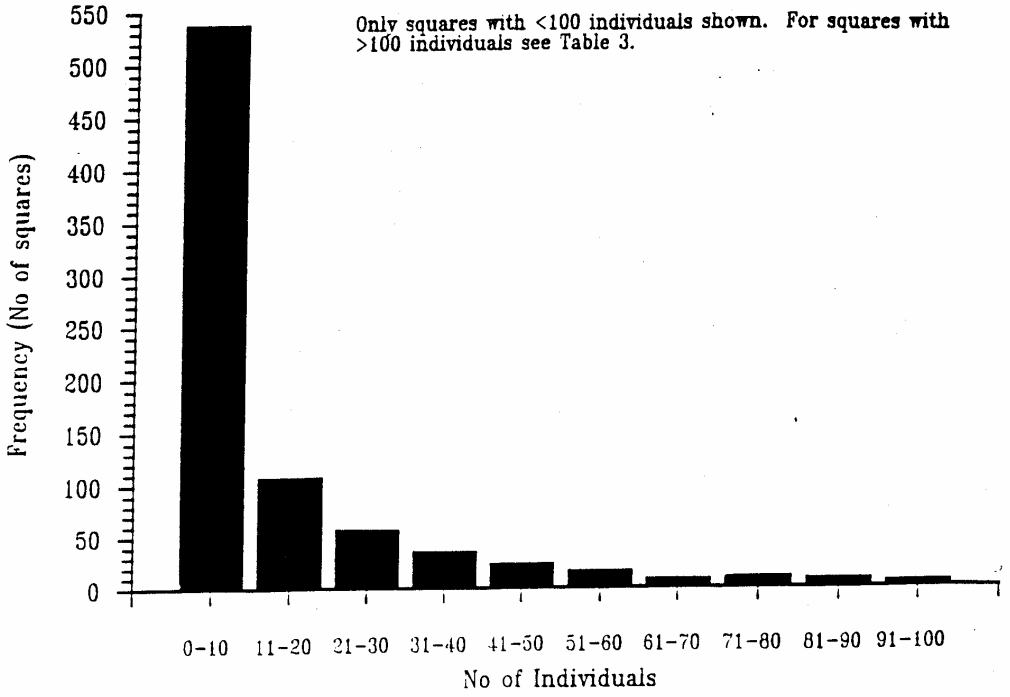
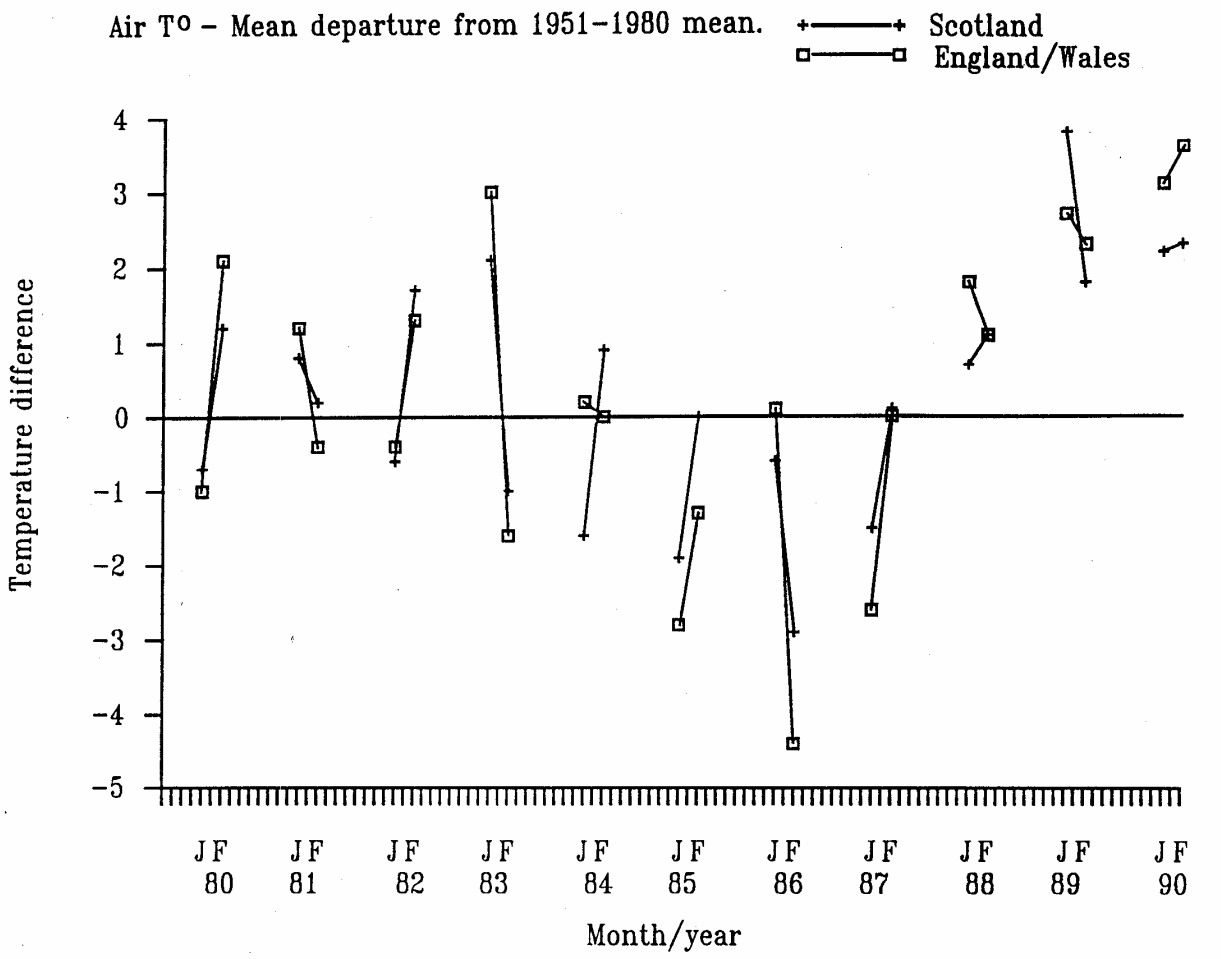


Figure 6. Mean difference in January and February air temperature from the average mean in Scotland and England/Wales 1980–1990.



APPENDIX 1

BTO/WWT/ SOC IWTE SWAN CENSUS 1990

NOTES FOR LOCAL ORGANIZERS

Thank you for agreeing to be a Local Organizer.

The objectives of this survey are:

1. To estimate population changes since the 1983 census and describe their geographical pattern, particularly in relation to the ban on the use of lead weights by anglers.

2. To estimate the current sizes of local and national populations.

3. To provide a baseline for future monitoring of this species.

There are several problems with mounting such a survey in 1990. One is that this is the last year of the New Breeding Atlas, so it will be difficult in some areas to put much work into the swan census without diverting observers from the atlas (which should have priority). The solution we have adopted is to allow coverage to vary locally, according to what local organizers and their fieldworkers feel is possible. Some areas will be able to achieve total coverage and thus get a good estimate of the swan population; in others it may be possible to cover only a few 10km squares, so the estimate of the total local population will be less precise; but provided that the proper methods are used, it will be pos to combine the various local estimates to get a good picture of the changes in populations and of the current national total.

A second problem is that, if one is to extrapolate validly from a sample of squares to the total, it is essential that the sample is random. But observers do not like being directed to random squares, which they may know to contain few or no swans or where covering the terrain' may be difficult. The problem is particularly acute for non-breeding swans, where a set of sample squares may miss the county's non-breeding birds (because they are in just a few flocks). Past attempts at random coverage have not achieved coverage of all of the randomly assigned squares.

We are attempting to get round these problems and to allow coverage to be varied locally by using the following methods.

Three types of records for a 10km square will be acceptable:

1. Complete coverage: an observer actually counting the swans in the whole square.

2. Partial coverage: an observer counting only part of a square but providing a 'best estimate' of the numbers in the uncovered area. (This estimate to be checked by you, the local organizer - see below). Please discourage observers from partial coverage, except where part of the square - comprises unsuitable habitat and is known already to contain no swans.

3. Probable blanks: squares that comprise wholly unsuitable habitat and that you and your local team know already probably to contain no swans.

Because swan populations have changed so much in some areas, we are reluctant to accept estimates, even when based on surveys done in recent years. But we hope that accepting some records of types 2 and 3 will allow you to achieve better coverage than if only complete coverage was acceptable.

You are provided with a list of the 10km squares in your area, arranged in random order, on a 'Regional Summary Sheet'. Please arrange coverage of as many of these as possible, starting at the top and working downwards. TO MAINTAIN ANDOMNESS, IT IS IMPORTANT NOT TO HAVE ANY GAPS IN YOUR LIST: COVERED SQUARES THAT ARE BELOW A GAP CANNOT BE USED IN MUCH OF THE ANALYSIS. To take an example, it will be better to get coverage of only the first 5 squares on your list than to get coverage of all the first 9 except the fourth. We hope that allowing partial coverage and "probable blanks" will let you fill gaps that might otherwise occur because observers do not want to visit squares that contain little or no suitable habitat.

The surveys of breeding pairs and of non-breeding birds can be done by different people (since different forms are used). The same random order of squares applies to both surveys. In addition to the normal coverage of squares in random order, please try to get counts of the major non-breeding flocks that are in otherwise unsurveyed squares.

The survey has been advertised in ETO News and elsewhere, so you may be contacted by volunteers or have other volunteers directed to you by the national organizers, to add to the potential participants with whom you are already in contact.
Enclosed with these notes are instruction sheets and recording f arms for your fieldworkers. If you need more, please let Simon Delany (England & Wales) or Allan & Lindesay Brown (Scotland) know.

Please enter your name and address on the forms you supply to observers, to ensure that they know to whom to submit them. When you have gathered in the forms, please

1. Check any estimated figures. Write notes explaining any disagreement: or commenting on the accuracy of the count on the form and sign your comments 'L.O.'

2. Fill in your regional summary sheet. (Two copies provided, so you can keep one for your records).

PLEASE RETURN THE SUMMARY SHEETS AND RECORDING FORMS TO SIMON DELANY (E & W) C)R ALLAN & LYNDESAY BROWN (SCO) BY 31 AUGUST 1990.

S.Delany, WWT, Slimbridge, Gloucester, GL2 7BT
A.W.& L.M.Brown, 232 Rullion Road, Penicuick, Midlothian, EH26 9JL
J.J.D.Greenwood, BTO, rrin Herts, HP23SNR

APPENDIX 1 cont….. MUTE SWAN CENSUS 1990

BRITISH TRUST FOR ORNITHOLOGY / WILDFOWL & WETLANDS TRUST / SCOTTISH ORNITHOLOGISTS' CLUB
INSTRUCTIONS TO COUNTERS

This census aims to produce an estimate of the total Mute Swan population of Great Britain and its islands, to discover how it has changed since previous surveys and to provide a base for future monitoring. It uses 10km squares of the National Grid as the census unit and the aim is to cover as many squares as possible. All records are required, of both breeding pairs and of non—breeding birds.

Census of breeding pairs (green form)

If possible all suitable habitat within each 10km square should be visited during April or May. Observations from March and June are welcome, but preferably mot as the only record of a pair. On locating a pair you are asked to prove breeding by finding the nest or seeing a brood of cygnets. Additional visits may be required for this. Checking the presence of eggs in the nest is not necessary.

A form is provided which should be completed on both sides (use one or more forms per 10km square). A sample form, with fictitious details, is shown on the reverse of these instructions. On one side is space for entering your observations under the following headings:

Site code	Please give a letter (A-Z) to each pair, nest or brood.
Location	Describe as exactly as possible, including the nearest town or village.
Grid ref	Enter the standard 6-figure Ordnance Survey National Grid reference. (Please remember to read the grid reference horizontally first, then vertically).
Habitat	This should be given as one of the following types: pond or lake, reservoir, gravel (or other) pit, river stream, canal, ditch (or rhine or dyke), estuary, sea—shore. If different from these, give details.
Date	For each visit give the day and month (in the form 9/4, 27/5, etc. as this will greatly help computer entry of the data).
Observations	Give details of observations using the following codes:

Pair on territory, but without nest	T
Pair with nest	N
Pair with cygnets	B
Pair known to have nested, but failed	D

On the other side of the form please insert the 10km square designation (2 letters and 2 numbers) in the top right hand corner, together with the name of the county (region and district in Scotland) and put your name and address in the space provided. The lOxlO grid on this side of the form represents the 1km grid within each 10 km square. Please mark the positions of the birds or nests you have found using the following symbols to represent the state you recorded on your final visit:

Territorial pair, no sign of breeding	X
Pair with nest	0
Pair with brood	I

A pair that nested and then failed should be marked with the symbol for its last known state before failing. Against each symbol write the letter used for the site code on the other side of the form.

Please cover the whole 10km square. If this proves impossible, please shade any parts that you have not covered. In the space provided please give your best estimate-of the number of pairs in the shaded part, as a number (eg 1) or a range (eg 1-3); write 0 if you think there are no swans in the shaded area. Remember that "Don't know' is a better response than a guess. Give reasons for your estimate. Please make every effort to cover properly all areas with suitable habitat rather than making estimates: remember that swans can nest on small pools in private land.

Census of mon-breeding birds and flocks (blue form)

Non-breeders may move about: try to minimize counting the same birds twice by covering your square in as short a time as possible. Full coverage in April is best: May counts are acceptable but by then some failed breeders may have already entered non-breeding flocks.

The form for non-breeding birds is similar in lay-out to that for breeding pairs, with spaces on one side for your observations and on the other to plot positions on a grid. Please record the site code, location, grid reference and habitat in the same way as for breedinc mairs, using the same list of habitats. A flock grazing on riverside marshes should be described as on, or by, a river. Dates (day and month) should be entered as 5/4, 27/5, etc, to aid computer entry. Give the number of birds recorded at each place.

On the other side of the form, enter the 10km square designation, the county (or region and district) name, and your name and address. The positions of birds and flocks should be marked on the grid with an X. Where a flock is known to wander up and down a stretch of river or canal, mark the extreme positions with Xs and join them with a Line.

Please cover the whole 10km square. If this proves impossible please shade any parts that you have not covered. in the box provided please give your best estimate of the number of non—breeding birds in the shaded part, as a number (eg 1) or a range (eg1-3); write 0 if you think there are no swans in the shaded area. Remember that "Don't know" is better response than a guess. Give reasons for your estimate. PLease make every effort cover properly all areas with suitable habitat rather than making estimates.

FORMS SHOULD BE RETURNED TO YOUR LOCAL RGANTSER AS SOON AS POSSIBLE AFTER 31 MAY
THANK YOU IERY OUCH FOR YOUR HELP

S. Delany, WWT, Slimbridge, Gloucester, GL2 7BT

Please mark on the grid the positions of all pairs and nests found, using the following symbols to represent the state you recorded on your last visit:

Territorial pair ... X
Pair with nest 0
Pair with brood .... ●

Against each symbol write the letter used for the site code on the other side of this form.

Please shade any parts of the 10km square that you were unable to cover. *

What is your best estimate of the number of pairs in the shaded part? What is your reason for this belief? *

0

NO SUITABLE HABITAT

Please write your name, address, and phone no. here:

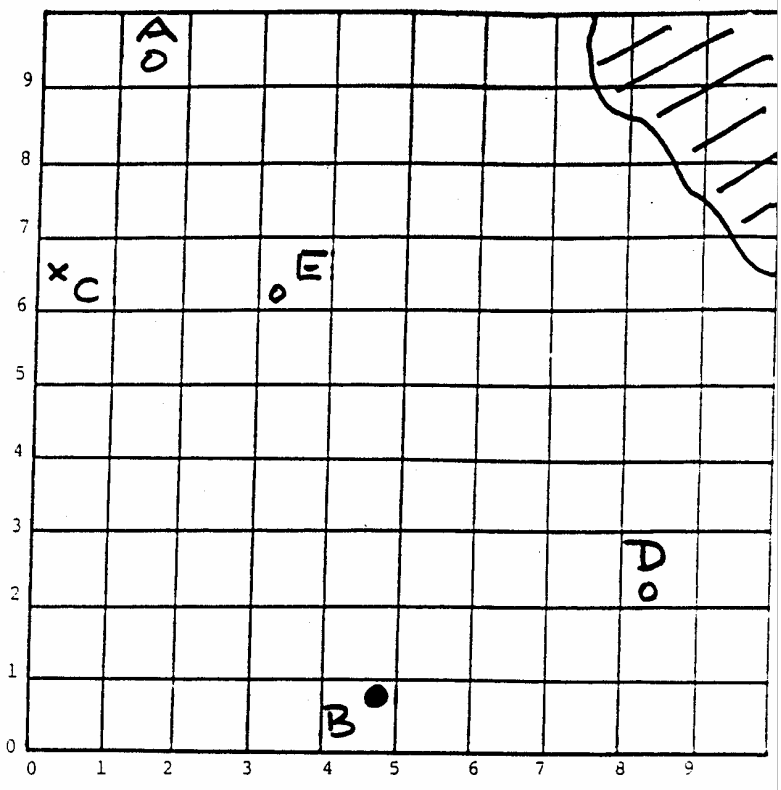
J. SMITH
1 FIELD ROAD
BRISTOL
AVON. BS1 1AA
654321

Your local organizer is:

SIMON DELANY
WWT, SLIMBRIDGE, GLOS.
GL2 7BT (0453-890333)

* Note: estimates are much less useful than proper coverage.

County (England & Wales) or District & Region (Scotland) AVON



As soon as possible after 31 May, please return to your local organizer.

MUTE SWAN CENSUS 1990: BREEDING PAIRS: OBSERVATIONS

te de	Location	Grid ref.	Habitat	Dates and observations (Dates as 00/0 please)
A	LITTLETON BRICKPITS, NR. WICK	716 092	GRAV. PIT	03/4 T, 15/4 N, 01/5 N
B	ALVESTON RES.	747 007	RESERVOIR	03/4 N, 01/5 N, 27/5 B
C	HILLSIDE LAKE, THORNHAM	701 065	LAKE	03/4 T
D	LITTLE AVON, NR. THORNBURY	784 021	STREAM	15/4 N, 07/5 D
E	R. SEVERN, FROME	733 062	RIVER	01/5 N

Appendix 2

Mute Swan Survey 1990
BTO Recording Regions

For names of recording regions refer to Table 1