THE DISTRIBUTION OF MALLARD RINGED IN SOUTHERN ENGLAND

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Summary

RECOVERIES of Mallard ringed at six stations in the south of England from 1947 to 1960 are used to study the homogeneity of the population. A large majority of the ducks were ringed in the months August-November and very few in the breeding season. Little emigration of autumn-marked Mallard occurs during the winter, though some move to France. Within Britain dispersal is usually over quite short distances. Circles of 10 miles radius around the three major stations (Abberton, Essex; Borough Fen, Northants; and Slimbridge, Glos.) include 81 (63%), 99 (22%) and 43 (22%) direct recoveries (in the same season). The "winter dispersion areas" of the three stations, defined as the areas containing the nearest 90% of direct recoveries, cover about 2,200, 13,800 and 10,500 sq. miles, with comparatively little overlapping. Recoveries in the breeding season (February to July in England) are much less plentiful than those in the shooting season, but they show a pattern of distribution similar to the "winter dispersion areas." The proportions of recoveries in England in later winters which are within the dispersion areas are very high : 86%, 86% and 85%. Smaller-scale ringing in Norfolk and Dorset confirms that most surviving Mallard remain in, or return to, their winter homes.

The winter population of Mallard in southern England includes immigrants drawn from a large area around the Baltic and from west Germany, Holland and northern France. The proportion of visitors from abroad seems to vary considerably from place to place. Precise estimates are impossible from the available data but it seems that about half the Mallard sampled in Essex which survive the winter emigrate the next spring. The corresponding fractions for Borough Fen and Slimbridge, though uncertain, are substantially less. No differences in the summer distribution of recoveries abroad are apparent. In the autumn after ringing the proportion of Essex-ringed Mallard taken in Holland is higher, and that of Borough Fen and Norfolk-ringed birds lower, than the average, suggesting that in the later stages of autumn migration some differentiation of routes occurs. No differences in the summer ranges of males and females are apparent.

Introduction

Ringing prior to 1939 in the British Isles and elsewhere enabled Landsborough Thomson (Results of Ringing Duck. *Factors affecting the general status of Wild Geese and Wild Duck,* pp. 84-105. Cambridge. 1941) to give a general picture of Mallard migration in Europe. Recently C.S.P. van Dam, on behalf of the International Wildfowl Research Bureau, has re-investigated the situation with the aid of a relatively large volume of ringing and recoveries from many countries since 1945. His analysis, not yet published, has provided a much more detailed picture, without substantially altering the earlier outline. Van Dam made extensive use of the data on which the present paper is based, but this insular inquiry is made with a different object : to see whether an intensive study of the movements of ducks within a small segment of the winter range can throw light on some general problems of migration and distribution.

Over 20,000 Mallard ringed at six stations in southern England since 1947 have provided the material used. Two of the ringing stations are operated by the Wildfowl Trust : Berkeley New Decoy, Slimbridge, Glos. and Borough Fen Decoy, Peakirk, Northants. Major General C. B. Wainwright operates a large number of cage-traps at Abberton Reservoir, Essex, with financial assistance from the Trust. M. R. and C. A. Boardman have caught ducks in cage-traps at Ludham, Norfolk for many years and P. L. Wayre used a cage-trap at Mileham, Norfolk, from 1951 to 1955. Small numbers of Mallard have also been caught for ringing in the decoy at Abbotsbury,

Dorset, by F. Lexster for the Earl of Ilchester since 1937. In this paper particular attention is paid to ringing at Abberton, Borough Fen and Slimbridge, where most ducks have been marked. Table 1 provides a summary of the numbers ringed at the major stations and recovered up to the end of July, 1960.

Table 1. Numbers of Mallard ringed at three major trapping stations in England, 1947-60 and recoveries reported to July, 1960. Figures in italics in last three columns express recoveries as percentages of numbers ringed.

Station	Period of ringing	Number ringed	Numbers so far recovered in Britain	%	overseas	%	Total	%
Abberton, Essex ..	1949-60	4618	943	*20*	272	*6*	1215	*26*
Borough Fen, Northants	1954-60	7033	682	*10*	166	*2*	848	*12*
Slimbridge, Glos. ..	1947-59	6698	755	*11*	189	*3*	944	*14*
total		18349	2380	*13*	627	*3*	3007	*16*

Quantitative interpretation of recoveries is beset with difficulties, many of them insoluable without additional information, most of which cannot be collected. For example, the intensity of shooting at different times in different

FIGURE 1. Direct winter recoveries of Mallard ringed at Abberton, Essex, August 1949 to February 1960. 81 recoveries at or within 10 miles of Abberton shown by circle not marked individually.

countries, the chances of rings being reported when found, the proportion of deaths not due to shooting, and so on. The following account is restricted to topics not likely to be undetectably biassed in an important way by reporting troubles.

Direct Recoveries

The most abundant and readily interpretable evidence from recoveries of ducks ringed in the autumn and winter consists of reports during the same season, here referred to as *direct* recoveries. Figures 1 to 3 show the distribution of direct recoveries in England and Wales of Mallard ringed at Abberton, Borough Fen and Slimbridge. Three recoveries further north are not mapped nor are one in Ireland and 34 in France. The pattern of dispersion is a familiar one, with the density of recoveries high near the ringing station and falling off rapidly with increasing distance. Circles of 10 miles radius around Abberton, Borough Fen and Slimbridge include 63%, 22% and 22% respectively of all the direct recoveries. Recoveries beyond this distance, though widely scattered, are clearly not randomly distributed throughout England. This is shown plainly in Figure 4 on which " winter dispersion areas " for the three stations are plotted. These areas are drawn so as to omit the outer 10% of the direct recoveries from each. The approximate sizes of the areas are 2,200, 13,800 and 10,500 sq. miles respectively (the

FIGURE 2. Direct winter recoveries of Mallard ringed at Borough Fen, Northants, August 1954 to February 1960. 99 recoveries at or within 10 miles of Borough Fen not shown individually.

FIGURE 3. Direct winter recoveries of Mallard ringed at Slimbridge, Gloucestershire, November 1947 to February 1959. 43 recoveries at or within 10 miles of Slimbridge not shown individually. (Mallard caught at Slimbridge in 1959-60 were used in transportation experiments and so have been ignored here).

total area of England bring 50,300 sq. miles). The only overlap between the areas is in the central midlands where ducks from Slimbridge and Borough Fen mix. The small size of the Abberton area is the more striking because the recovery rate for Abberton birds is high. London appears to form a barrier between the Abberton and Slimbridge areas. The Mallard population of the city is quite large and is not wholly sedentary, so that the lack of recoveries from London may reflect the absence of shooting there rather than the non-occurrence of marked ducks.

Table 2. Numbers of direct winter recoveries of Mallard ringed at Abberton, Borough Fen and Slimbridge. One Borough Fen bird recovered in Ireland is not included.

	recoveries reported in		recoveries per 1000 marked	
	England and Wales	France	England and Wales	France
Abberton	307	15	66	3
Borough Fen ..	458	9	65	1
Slimbridge	192	10	29	2
total	957	34	52	2

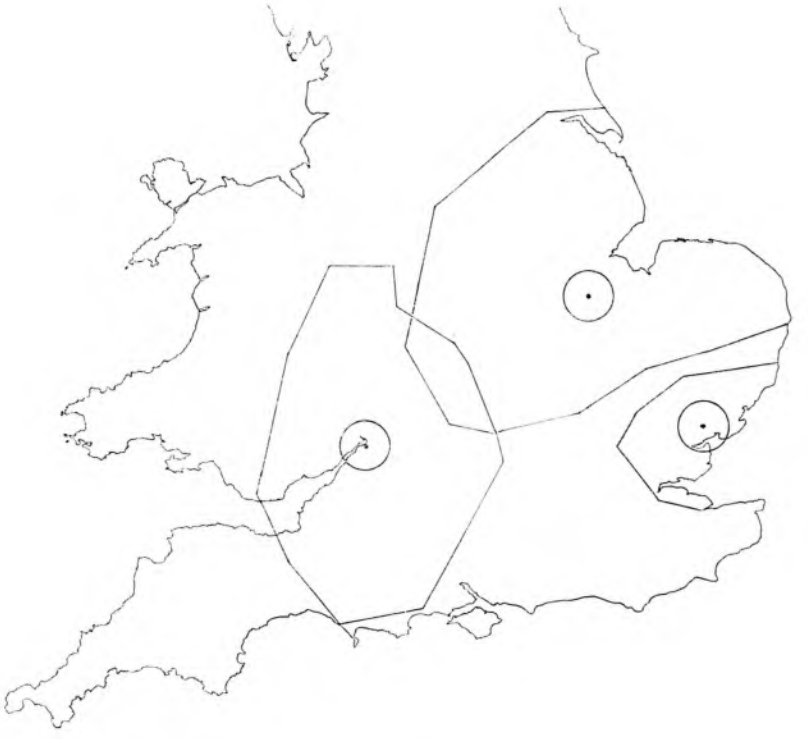

FIGURE 4. The " winter dispersion areas " of Mallard ringed at Abberton, Borough Fen and Slimbridge. Each area is drawn to exclude the 10% of the direct recoveries furthest from the ringing station.

Emigration to France during the winter (October-February) seems to be on a comparatively small scale (Table 2). With no means of determining whether the probability of reporting differs greatly between France and England the apparent proportion of emigrants to winter residents (about 4%) cannot be taken as reliable, but in view of French enthusiasm for *la chasse* it seems unlikely that a substantially greater fraction of the stock emigrates. The suggestion that more Abberton-caught Mallard move to France than do those from Slimbridge and Borough Fen has some bearing on the discussion of autumn movements from the Baltic to England in a later section. The virtual absence of movements to Ireland is in strong contrast to the behaviour of Teal and nearly all other ducks that have been ringed in England.

There have been no major variations in the pattern of dispersion between different seasons. Nor are significant differences apparent between ducks ringed early in the season and those ringed later.

Recoveries in Spring and Summer

Because shooting in spring is illegal in Britain and in most other countries of north-west Europe the numbers of recoveries from March to July are small and their interpretation difficult. In August shooting is resumed in most places, though not in Britain (since 1955) : but by then Mallard may

have moved far from their nesting places, before or after the flightless period of the moult, so that recoveries in July and August do not necessarily record breeding distribution.

Figure 5 shows the spring and summer distribution of recoveries in Great Britain. No distinction between five recoveries in July and August and those earlier is made, because they are not markedly different in scatter. The "summer dispersion areas," determined like the winter ones in Figure 4 by the exclusion of the outer 10% from each station, show considerable resemblance to those winter areas, though there is a substantial overlap

FIGURE 5. Recoveries in the British Isles in March-August of Mallard ringed at Abberton, Borough Fen and Slimbridge. "Summer dispersion areas," excluding the outer 10% of recoveries.

between the Abberton and Borough Fen regions. The number of Mallard found dead where ringed is high at Slimbridge, where many nest and where bodies of dead ducks are more likely to be found. There have been none at Borough Fen, where no ducks nest. From Figures 1 to 5 it seem unlikely that large-scale shifts of British-breeding Mallard take place, at least to or from southern England (a conclusion reached by Landsborough Thomson long ago).

The breeding season recoveries overseas (Figure 6) give no indication of segregation according to the place of marking. The chance of recovery in summer is so small that any differences in distribution which might exist are perhaps liable to be masked by chance effects. The few recoveries in England of Mallard marked at their breeding places in Finland and Sweden have been widely scattered and offer no support for the hypothesis of segregation.

Indirect recoveries abroad in late summer, autumn and winter

Recoveries in the Baltic area in the months August-October of English-ringed Mallard are mapped in Figure 7. This does not differentiate between ducks ringed at the various stations because, as in the April-July recoveries, no differences in distribution are evident. The main features of the map show, first, how Mallard from the eastern part of the breeding range become confused with those further west and, second, that the evacuation of the Baltic is apparently a very gradual process.

FIGURE 6. Recoveries overseas in March-July of Mallard ringed at Abberton, Borough Fen, Slimbridge, Abbotsbury (Dorset) and in Norfolk.

FIGURE 7. Recoveries *in the Baltic area* in August (solid circles), September (open circles) and October (crosses) of Mallard ringed in England. Recoveries in Denmark, Germany and Holland, too numerous to be shown here, are tabulated in Table 3.

Early autumn recoveries in Denmark, Germany and Holland are too numerous to be shown individually on a map. They are summarised in Table 3. Close scrutiny reveals few differences in the cell entries from the numbers expected from the row and column totals. The only clearly significant departures from expectation refer to Abberton-ringed birds. There are half as many again in Holland and only half as many in France as would be anticipated. Other less striking discrepancies suggest a reversal of this result for Borough Fen birds (fewer in Holland, more in France); Norfolk-ringed birds provide relatively many Danish and German and few Dutch recoveries. It is easy to explain the high proportion of Abberton-ringed birds taken in Holland in terms of a difference in the journeys of Essex-bound and Wash-

Table 3. Recoveries of English-ringed Mallard from August to October in Denmark, N.W. Germany, Holland and northern France.

where recovered	where ringed				
	Abberton	Borough Fen	Slimbridge	Norfolk	total
Denmark	11	16	16	6	49
N.W. Germany ..	7	8	13	6	34
Holland	41	18	28	2	89
France	6	14	14	2	36
total	65	56	71	16	208

bound stocks, but the occurrence of recoveries in France in autumn is less readily accounted for, especially in view of the direct recovery rates (Table 2) which show Abberton birds more frequently moving to France in winter than those from elsewhere.

Table 4. Recoveries overseas in November-February of English-ringed Mallard. 32 same-season recoveries in France (shown in parentheses), the remainder in later winters.

where recovered	where ringed: Abberton	Borough Fen	Slimbridge	Norfolk	Dorset	total
Baltic area ..	3	4	2	1	0	10
Denmark ..	10	5	7	7	1	30
N.W. Germany	3	5	5	3	1	17
Central Europe	2	1	4	0	0	7
Holland ..	17	13	8	8	6	52
France ..	(14+)10	(9+) 5	(9+)16	1	2	34(+32)
total	45	33	42	20	10	150

Indirect recoveries overseas in the months November-February (Table 4) throw no further light on the problem. The only departures from expectation are in the Slimbridge-ringed column, with too few Dutch and too many French, and in the Norfolk sample with unexpectedly many in Denmark and few in France. The latter discrepancies are as likely to be associated with date of ringing as with place, since nearly all Mallard ringing in Norfolk has been done in January and February, so that the sample is especially liable to include late immigrants.

Indirect recoveries in Britain in autumn and winter

Table 5 summarises the occurrence of recoveries in Britain in the second season after marking for Mallard ringed at the three major stations. The most striking and important point that emerges is brought out by the second column of figures. It will be recalled that the winter dispersion areas were defined to contain 90% of the direct recoveries from each station. Column two shows that these areas also contain 86% of the second-season recoveries in Britain. This suggests not only that most of the English-resident Mallard are nearly sedentary but also that immigrants tend to return to the same wintering area. Recoveries in later seasons, though relatively few, show very similar results.

Table 5. Recoveries of English-ringed Mallard in Britain in the second season after marking (September-February) in the years 1955 to 1960. Italic figures in the second column show recoveries in the winter dispersion area as a percentage of the total recoveries in Britain during the second season.

where ringed	recoveries: dispersion area		outside	total	recoveries per 1000 marked: in area	outside	total
Abberton	101	*86%*	16	117	52	8	60
Borough Fen ..	150	*86%*	24	174	30	5	35
Slimbridge	82	*85%*	14	96	19	3	23
total	333	*86%*	54	387	31	5	36

Another obvious feature of Table 5 is the difference in the second-season recovery rates for each sample, which are high for Abberton and low for Slimbridge, especially within the winter dispersion areas but also beyond them. If attention is concentrated on recoveries within 10 miles of the ringing station the second-season recoveries show even greater differences: Abberton 76 (3.9% of those marked), Borough Fen 38 (0.9%) and Slimbridge 24 (0.6%). The simplest explanation would seem to be that either shooting pressure or the reporting-rate is greatest in the Abberton area : although the first-season recovery-rates for Abberton and Borough Fen are very similar to each other (Table 2).

Table 6. Recoveries, other than by shooting, in the months March to August inclusive of Mallard ringed at Abberton, Borough Fen and Slimbridge. Records from all years, 1948 to 1960.

where found	ringed			
	Abberton	Borough Fen	Slimbridge	total
in Britain	16	38	57	111
overseas	15	10	20	45
total	31	48	77	156
% overseas	*48*	*21*	*26*	*29*
where found	recoveries per 1000 ringed			
	Abberton	Borough Fen	Slimbridge	total
in Britain	3	5	9	6
overseas	3	1	3	2
total	7	7	11	8

The proportion of migrants

It is of practical importance as well as theoretical interest to find out what proportion of the stock of Mallard in England in autumn and winter is of foreign origin since this bears directly on sound 'harvesting' practice. Unfortunately sampling difficulties prevent a satisfactory solution of the question, though some approximate answers can be given from the recovery data. The most direct approach is by a comparison of the numbers of recoveries in the breeding season at home and abroad (Table 6). Because of differences between countries in the legality of summer shooting it is desirable to consider only recoveries not due to deliberate killing by man. Since summer shooting is much more common abroad than in Britain, recoveries due to shooting falsely suggest that most Mallard breed overseas. But restriction to reports of accidental deaths reduces the number of recoveries to a very low level (a rate of 8 per 1000 marked, against 54 for first-winter and 60 for second season): and the chances of dead ducks being found vary widely from place to place. For example, at Slimbridge where many Mallard attempt to breed in an area searched intensively for nests the chances of dead ducks being found are unusually high, as Table 6 shows. No generalisations about the conditions overseas can be other than guesses. The ratios found abroad : all found suggest that about 3/10 of English-ringed

Mallard may have been of foreign origin, nearly half those marked at Abberton but only a fifth of those at Borough Fen coming from abroad. The recovery-rates also indicate a lower proportion of 'foreigners' in the Borough Fen sample than the Abberton one.

A second method of approach is to compare the numbers of second-season recoveries at home and abroad (Table 7). Because of possible differences in 'shooting pressure' there is no reason to expect that the ratio foreign : all reported will be close to the ratio breeding abroad : breeding in England, though in fact this ratio for the total sample (32%) resembles the ratio of summer recoveries (29%). The ratios for the different stations are particularly liable to be affected by differences in reporting in England, already mentioned, since British recoveries exceed those abroad, and the indication that Slimbridge-ringed Mallard include a higher proportion of foreigners than the others is particularly suspect. The recovery rates (lower part of Table 7) suggest, in agreement with the approach in Table 6, that the Abberton sample includes more immigrants than those of Borough Fen and Slimbridge. This result is emphasised by Table 8, in which attention is concentrated on the relative numbers shot in early autumn in the Scandinavian and Russian breeding areas. (Most of the data of Table 8 are included in those of Table 7, so that the two are not independent).

Table 7. Recoveries from all sources in the second season (September-February) of Mallard ringed at Abberton, Borough Fen and Slimbridge, 1954 to 1959.

where found	recoveries			
	Abberton	Borough Fen	Slimbridge	total
in Britain	117	174	96	387
overseas	48	71	63	182
total	165	245	159	569
% overseas	*29*	*29*	*40*	*32*

where found	recoveries per 1000 ringed			
	Abberton	Borough Fen	Slimbridge	total
in Britain	60	39	22	36
overseas	25	16	15	17
total	85	55	37	53

Though there is a definite impression from Tables 6-8 that Abberton Mallard include the greatest proportion of migrants, it does not seem possible to decide on this evidence whether Borough Fen has more migrants than Slimbridge.

Table 8. Recoveries in Scandinavia and Russia in August-October of Mallard ringed at Abberton, Borough Fen (1954-59) and Slimbridge (1947-59).

	recovered				per 1000 marked
	August	September	October	total	
Abberton	15	16	6	37	19
Borough Fen ..	32	15	13	60	9
Slimbridge	26	15	5	46	7

While it is not proposed to discuss the survival of ringed Mallard here, it is relevant to note that, though the Abberton recovery-rates in autumn and winter are high, there is evidence that the annual mortality rate of Abberton-ringed Mallard is no higher than that for ducks ringed at the other major stations (Boyd, unpublished report).

Distribution of the sexes

No distinction has been drawn in earlier parts of this paper between the distribution of males and females. This is because few differences seem to exist. There is no evidence of segregation in summer either in Britain or abroad and the apparent ranges overseas are as nearly identical as could be expected from the rather small number and wide scatter of recoveries. Nor do the same-season winter emigrants to France consist predominantly of one sex. There are some indications that in autumn immigrant males tend to move ahead of females, a finding consistent with those of other studies (e.g. E. Bezzel, *Anzeiger Orn. Ges. Bayern*, 5 : 269-355, 1959) but the exploration of these differences needs evidence from observations as well as from ringing and will not be pursued here.

Investigation of possible differences in the behaviour of young and old birds has been greatly hampered by difficulty in identifying first-winter birds caught later than September and it is necessary to accumulate more material before reporting definitely. Present indications are that no major differences will be found.

Some practical implications

This investigation has two results of some importance to effective conservation of the Mallard in Britain. First, the concept of " dispersion areas " shows that even within an area as small as the southern half of England there exist different stocks of Mallard which behave independently. Second, foreign-bred Mallard seem to be in a minority in southern England, though the proportion varies from stock to stock. It follows that effective conservation of Mallard stocks, by provision of refuges or feeding areas, by control of shooting or in other ways, will best be tackled by regional rather than by national management plans. Since this is a consequence of the relative importance of home-bred birds in the Mallard population it does not necessarily apply to other species, such as Teal and Wigeon, in which home-bred birds make up only a tiny proportion of the wintering stock. The evidence of sedentariness is particularly encouraging also to the proponents of the release of hand-reared Mallard as a means of increasing local stocks because it shows that the effectiveness of such schemes should be apparent on a local level.