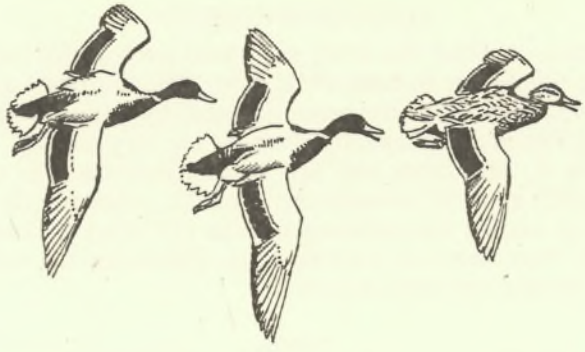

SOME RESULTS OF RECENT BRITISH MALLARD RINGING

By Hugh Boyd

SINCE the Mallard is the most numerous and widely distributed duck in Britain as a breeding species and probably as a wintering species also, information on its status, and particularly on changes in the dynamics of the British population, is of especial importance to wildfowlers and other students of ducks. In recent years investigations by several American biologists have enabled great advances to be made in the techniques of interpreting recovery data and in knowledge of the Mallard populations of North America. These American studies have been based on extensive ringing in many parts of Canada and the United States. Hickey (1952) found that 275,000 Mallards had been ringed and 40,000 recovered by the end of 1946 and since that time the American ringing effort has been greatly increased. By comparison, the scale of British ringing is very small indeed, only about 13,000 Mallards having been marked from 1909 to 1952.

Landsborough Thomson (1941) has summarised the information on the status and migrations of Mallard given by ringing before 1939. The movements of the species will not be considered in this paper, except for their effects on the use of recoveries of ringed birds in the study of mortality and its causes.

Between 1939 and 1949 very few Mallard were ringed in Britain. Almost all those ringed since 1949 have been caught at Abberton Reservoir, Essex (about 1600 birds), where intensive trapping is carried on by Maj-Gen C. B. Wainwright, or at Berkeley New Decoy, Slimbridge (about 2000 birds). Captures of ducks at these places and their recoveries there or elsewhere, with some references to earlier ringing, are used to answer three questions and illustrate some of the problems involved in making valid inferences about the distribution and mortality of the species from recoveries of marked birds. The questions considered are : (1) Is the mortality of British Mallards in their first winter higher than that of older birds ? (2) Why is the proportion of males recovered higher than that of females ? (3) What is the significance of variations in the sex-ratio amongst ducks caught at different times of year ?

The Relative Mortality of Adult and Young Mallard

Höhn (1948) has published an analysis of recoveries of Mallard ringed in Britain up to 1946. He found that of 305 recoveries of ducks ringed as adults, 65·3% were obtained during the first year after ringing, 23·9% during the second year, 6·6% during the third year and 4·2% in subsequent years, while

of 828 recoveries of ducks ringed as young, 89·0% were obtained during the first year after ringing, 9·6% during the second year, 0·6% during the third year and 0·8% during succeeding years. Blake (1949) has criticised these findings on statistical grounds, but used Höhn's published data to provide a simpler demonstration of the decline of mortality with increasing age. Blake's method, the calculation of age-specific mortalities (i.e. the percentages the losses in any year bear to the number exposed to risk at the beginning of the year) leads to the result that the mortality in the second year of life of ducks ringed as juveniles is closely similar to that in the first year (87·0% as compared with 89·0%) but drops sharply in the third (41·6%) and fourth years (42·9%).

The figure of 89% for first-year mortality is at first sight very large though Hickey (*loc. cit.*) believes ' that the high degree of reproductive success necessary to maintain the British Mallard population at the replacement rate entailed by this mortality is within the limits of reproductive efficiency in this species.' Scott (1951) used Höhn's results to assert that ' 89 *per cent.* of Mallards in Britain die in their first year,' which provoked Parish (1951) to declare: 'To wildfowlers this is a ridiculous statement, and it appears that Dr E. O. Höhn's analysis of the *recoveries* of ringed Mallards published in *British Birds*, *may* have been misread and wrongly interpreted.' Parish offers an alternative interpretation of the data. He points out that the 736 young and 199 adults recovered within one year of being ringed constitute 13·3% of all Mallards ringed, ' not the 89 per cent. upon which Commander Scott appears to have based his case against the shooting man,' apparently with the intention of substituting the former for the latter as an estimate of the first-year mortality rate. He had already noted that the total of recoveries at all ages represents only 16% of the ducks ringed. This attempt to confer immortality on 84% of ringed ducks invites ridicule not merely from wildfowlers.

Scott's generalisation of Höhn's result is valid only if recoveries of ringed birds may be taken as representative of the mortality of all British Mallards. It would be surprising if this were so because of the many sources of bias in the use of recovery data for estimating mortality, and particularly because of the preponderance of hand-reared and possibly-hand-reared birds in the sample available in 1947. The ringing at Abberton and Slimbridge in the last four years cannot provide estimates of mortality rates for another seven years or so (when the number of ducks marked in 1949–51 still liable to recovery will be negligibly small), but it is possible to derive from the recoveries *mortality quotients* which should indicate whether first-year mortality is greater than that in subsequent years. The first-year mortality quotient M_1 is given by the equation

$$\text{mortality quotient } M_1 = \frac{\dfrac{\text{number of juveniles recovered within 1 year of ringing}}{\text{number of juveniles ringed}}}{\dfrac{\text{number of adults recovered within 1 year of ringing}}{\text{number of adults ringed}}}$$

This equation was suggested by Bellrose (Bellrose and Chase 1950) for the calculation of V_1, the vulnerability quotient, but the same author has also drawn the useful distinction between *mortality* as deaths from all causes and *vulnerability* as deaths from shooting. Thus V_1 should be calculated for recoveries from shooting only, where M_1 is derived from recoveries from all sources.

The use of the mortality quotient (M_1) depends on several assumptions. An initial difficulty is the identification of juveniles and adult birds. The principal criterion of immaturity used at Slimbridge was the presence of juvenile rectrices.

These are replaced in the early autumn, so that by the end of September many ducks cannot be assigned to age-classes by this means. In the calculations reported here only those birds ringed on or before 15 September and confidently assigned to one or other class have been used. At Abberton, General Wainwright has employed the width of the rectrices as a criterion (the first-winter as well as the juvenile feathers being relatively narrow) and has assigned birds to age-classes even as late as March, but to assist comparison a restriction to birds ringed prior to 15 September has been imposed on the Abberton data also. There is an additional reason for giving particular attention to birds ringed in the late summer. Most of the recoveries are due to shooting. It has been argued that young birds are more vulnerable than old ones, but also that they become less vulnerable with experience during the shooting season. The season opens on 12 August. Ideally, therefore, comparison should be limited to birds ringed before that date, but this would make it very difficult to obtain a large sample, for very few adults can be caught in June and July. The inclusion of birds ringed after the opening of the shooting season must, however, be expected to tend to obscure any difference in vulnerability between young and old birds that is consequent upon experience.

TABLE I

First-season Mortality Quotients of British-ringed Mallard. (Restricted to recoveries before 1 August after ringing)

Locality and Period	Juveniles			Adults			Mortality Quotient M_1
	Ringed	Recovered	%	Ringed	Recovered	%	
Abberton (1950–52) ringing before 15 Sept.	293	91	32·2	162	27	16·7	1·86 (statistically significant)
Abberton (1950–52) ringing later than 15 Sept.	520	55	10·6	552	60	10·9	0·97 (not significant)
Slimbridge (1949–52) ringing before 15 Sept.	361	26	7·2	112	10	8·9	0·81 (not significant)
Abberton + Slimbridge, early ringing only	654	117	17·9	274	37	13·5	1·32 (not significant)

Table I records the values of the mortality quotient (M_1) for birds ringed at Abberton and Slimbridge. No earlier British marking effort has included sufficient numbers of both adults and juveniles to be used for comparison. There is an evident lack of agreement among the samples. The mortality of juveniles ringed early in the season at Abberton is much greater than that of adults ringed there at the same time. The Slimbridge figures actually suggest the opposite, a lower rate amongst young birds. While the Abberton data show a statistically significant difference between the age-classes, the apparent difference in the Slimbridge data may have been due to sampling errors, but in any event the latter give no support to the hypothesis of greater juvenile vulnerability and when combined with the Abberton results give a value of M_1 which, though greater than 1·0, is not significantly so. Thus if both samples are admitted as

representative, the hypothesis of high juvenile vulnerability is not adequately verified.

The discrepancy between the first-season recovery rate of juveniles ringed early in the season at Abberton (32·2% of birds ringed) and Slimbridge (7·2%) is very marked. The comparison of M_1 for early-ringed and late-ringed Abberton birds is of considerable interest in this connection. It appears that young birds not ringed till late in the autumn show a recovery rate during the period before the next shooting season almost the same as that of adults ringed at the same time (and, incidentally, similar to that of early-ringed Slimbridge adults). This suggests that in a population like that sampled at Abberton the high mortality rate of young birds is due mainly to deaths early in the first autumn. These deaths are almost all due to shooting and nearly all in the vicinity of the ringing station. Of the 91 first-season recoveries of early-ringed Abberton juveniles 87 (96%) were local (i.e. within 30 miles), whereas only 17 (65%) of the 26 early-ringed Slimbridge juveniles were local. Bellrose and Chase (*loc. cit.*) studying a Mallard population in Illinois, U.S.A., obtained a similar result, the mortality rate and vulnerability rate of juveniles being each about one-and-a-half times those of adults. Though it is not possible to determine values of M_1 from the data published by Hickey (*loc. cit.*), he calculates the first-year mortality rate of a small sample of juveniles as 68%, and a mean adult mortality rate (from a large sample) of 47·8%, indicating a similar ratio between juvenile and adult mortality.

The anomalous results from the Slimbridge data may be due in part to the presence among the young birds of a high proportion of ducks reared in or near the S.W.T. enclosures, although no *hand-reared* birds are included in the sample (and, at least since 1950, the adults also must be supposed to include many birds of similar origin). Some Mallards were hand-reared at Slimbridge in 1948 and 1949, primarily to provide a ' lead ' for the decoy in which the wild birds are caught. Recoveries from these 139 ' call-ducks ' totalled only 6 (4·3%) within 1 year of ringing, compared with 7·2% for other Slimbridge juveniles and 31·1% for Abberton juveniles, and only 3 of these 6 were shot. Thus the apparent vulnerability of these ducks is very low, in strong contrast to that of most of the hand-reared ducks marked elsewhere in Britain and used by Höhn in his analysis. Presumably this is due to the absence of shooting close to the Trust enclosures, together with less than the usual amount of local movement, as well as little migration in the customary sense, though one of these ducks has been recovered in Germany. The absence of recoveries at a distance is very striking in the pre-war hand-reared samples also. Höhn (*loc. cit.*) considers that ' there is no *a priori* reason to assume a difference in survival of young birds hand-reared as compared to those reared by their mothers,' but Hickey (*loc. cit.*) believes that ' it would be more conservative to assume that—until facts are available—some hand-reared waterfowl will adopt human beings as " social companions " and become unduly vulnerable to hunting as a result.' He demonstrates also that, although no differences in first-year mortality between wild-reared and hand-reared ducks is apparent in Höhn's data, hand-reared birds have a significantly higher *adult* rate of mortality than wild-reared birds. The present study confirms the existence of differences in survival among hand-reared and wild ducks, and the undesirability of using samples of mixed or uncertain origin for the determination of population parameters. Hickey based his belief that hand-reared waterfowl will tend to adopt human beings as ' social companions ' on the work of Lorenz (1937), but it is doubtful whether ' imprinting ' occurs in

the Mallard (Fabricius and Boyd, unpublished). It seems probable that the abnormal mortality rates of hand-reared young are due to their sedentary habits, not to tameness. Reared for shooting they get shot, reared with protection they survive exceptionally well.

Blake's (*loc. cit.*) finding that mortality in the second year of life is similar to that in the first year but is much reduced in subsequent years requires verification for a sample free of hand-reared birds, but the recent ringing does not enable this point to be satisfactorily explored. Hickey (*loc. cit.*) reports on a comparison of hand-reared and wild-reared North American birds. The wild-reared birds showed mortality rates of 68% in the first year and 50% in the second and subsequent years, whereas the mortality rate of hand-reared birds was 82% in the first year, 70% in the second, and 49% thereafter.

Sex Differences in Recovery Rates

Table II records the number of Mallards of each sex ringed and recovered (birds ringed before 1 March, 1953, recovered before 1 June, 1953).

TABLE II

Ringing and Recoveries of Male and Female Mallard

Where Ringed	Males			Females		
	Ringed	Recovered	%	Ringed	Recovered	%
Abberton	901	170	18·9	651	135	20·7
Slimbridge	975	158	16·2	930	93	10·0

Recoveries here are *final recoveries* of dead birds, excluding recaptures where ringed or captures elsewhere if the bird was subsequently released. For Abberton-ringed birds there is no significant difference in the recovery rates of males and females, but for Slimbridge-ringed birds the male recovery rate is much higher than that of females.

The American studies (see especially Hickey *loc. cit.*) have shown that the *recovery* rate of males is higher than that of females but that the *mortality* rate of females is higher than that of males. The higher female mortality rate is ascribed to the increased hazards to which females are exposed in the breeding season, while the higher male recovery rate is a consequence of their greater vulnerability. (Rings on shot birds are more likely to be reported than those on birds dying from natural causes.) Discussion of the British data must be restricted to inferences from recovery rate and causes of death.

Table III groups recoveries by the cause of death (recoveries for which no information on cause of death is available are omitted here). The proportion of recoveries due to shooting does not vary importantly with the place of ringing but there is a significantly higher proportion of shooting casualties amongst males than females. The apparently greater proportion of females captured in decoys could result from chance but the greater proportion of losses due to predators and accidents amongst females seems very likely to be a genuine indication of a higher mortality rate. This is probably largely brought about in the breeding-season (74% of female casualties in this category occurred from March to July, inclusive, compared with 57% of similar male casualties in the same period). This sample is as yet too small to establish the sex difference in

TABLE III

Reported Causes of Death of Male and Female Mallard

Sex	Where Ringed	Cause of Death			Total Recoveries
		Shot	Killed in Decoy	Predators or Accident	
Male ..	Abberton	119 (76·2%)	25 (16·0%)	12 (7·7%)	156
	Slimbridge	98 (79·6%)	7 (5·7%)	18 (14·6%)	123
	Total	217 (77·6%)	32 (11·5%)	30 (10·8%)	279
Female ..	Abberton	75 (64·7%)	27 (23·3%)	14 (12·1%)	116
	Slimbridge	51 (70·8%)	2 (2·8%)	19 (26·4%)	72
	Total	126 (67·0%)	29 (15·4%)	33 (17·6%)	188

mortality rate beyond doubt. The British results seem to be in agreement with the North American ones. It remains to be explained why males are more likely to be shot than females. Is this due to selection by wildfowlers or to differences in the behaviour of the sexes?

Can Abberton- and Slimbridge-ringed Mallard be Regarded as Representative?

The section on the relative mortality of young and adult ducks showed a discrepancy between the results obtained from ringing at the two stations. Table III reveals further differences. The greater proportion of Abberton-ringed ducks taken in decoys is due to the proximity of one of the three British decoys still being used to catch ducks for the market. The apparently greater proportion of Slimbridge birds falling victim to accidents is almost certainly due to the very high density of the local breeding population, in an area very carefully searched for ducks' nests (and bodies). Such variations are bound to occur and the obvious way to prevent local factors from unduly influencing results which are intended to reflect regional conditions is to catch ducks in as many places as possible. But, even if this can be done, it is necessary to show that the behaviour of ringed birds is similar to that of unringed ones. It is, of course, not possible to do this directly. The best that can be done is to correlate population parameters of marked and unmarked birds if any opportunity arises and, if no serious disagreement is found, proceed on the hypothesis that marked birds are representative. The following section illustrates one such correlation and, on the basis of agreement, some deductions about the movements of Mallard populations.

Age- and Sex-Ratios of Ringed Mallards

The decoy at Slimbridge constitutes a rather complicated kind of trap, for ducks may be taken in three more or less distinct ways. Birds using the pipes as resting places are liable to be caught by being frightened at the sudden appearance of a human being at the show-place. Birds resting on the pond, rather than in the pipes, may be first lured by the use of a dog and then frightened. Third, at the times when most Mallard are visiting the pond, the pipes are made more attractive by baiting with grain. Ducks using the pond as a refuge may be

regarded as wild, in contrast to the not inconsiderable number of Mallards which are virtually resident in the pens adjacent to the decoy. At the time when the decoy is being baited there is probably some movement of pen-inhabiting birds into the decoy, but even so the birds that are caught are more typical of the estuary population than of the resident population as the tame birds often are not sufficiently frightened to be caught. Though many Mallards caught in August and September are recaptured once or even twice in the same season very few are repeatedly recaptured, and comparatively few reappear in subsequent years. Table II shows, incidentally, that the sex-ratio amongst ducks caught at Slimbridge is very nearly 100 : 100. Counts of the sex-ratio of duck in the pond give a similar result when considered as a whole, so that there is no reason to suppose that the sexes differ greatly in their liability to capture in the decoy. Mackworth Praed (1941) also found males and females equally susceptible to trapping after comparing catches and counts at Orielton Decoy in 1934–39, even though females of all species were more numerous than males there.

From Table II it is seen that there is a marked preponderance of males in the catch at Abberton. At this station catching is done with baited traps, sited around a large reservoir which is in itself a refuge more than a feeding-place (for dabbling ducks at least). Some ducks develop a ' trap-habit,' using the traps as a source of food and being repeatedly recaptured. There is some evidence of differences between the sexes in this respect and observations show that males tend to push into traps ahead of females. Consequently the sex-ratio in the trapped ducks is unlikely to be typical of the unmarked population so that hypotheses derived from the sex-ratio should be treated with reserve.

TABLE IV

Catches of Male and Female Mallard at Abberton and Slimbridge

Period	Abberton				Slimbridge			
	1950–51		1952–53		1950–51		1952–53	
	Male	Female	Male	Female	Male	Female	Male	Female
April–July ..	6	5	34	26	10	1	5	4
August	3	8	101	62	45	36	51	48
September ..	19	12	58	60	292	225	227	201
October ..	30	32	77	24	63	74	69	78
November ..	37	25	138	83	2	2	4	8
December ..	27	39	106	62	6	7	4	3
January ..	5	7	29	31	6	5	6	15
February ..	6	6	13	9	1	7	3	5
March	21	25	—	—	2	4	—	—
Total ..	154	159	556	357	427	361	369	362

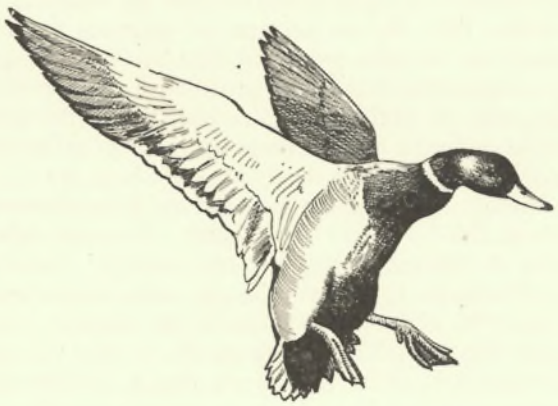

TABLE V

Sex-Ratio in Catches of Mallard at Abberton and Slimbridge. Ratios expressed as males per 100 females. Derived from data in Table IV

Period	Abberton		Slimbridge	
	1950–51	1952–53	1950–51	1952–53
April–July ..	—	131	—	—
August	—	163	125	106
September ..	158	97	130	113
October	94	321	85	88
November ..	148	166		
December ..	69	171		
January	84	105	78	55
February				
March	84			
Season ..	97	156	118	102

Table IV records the numbers of each sex caught in each month at Abberton and Slimbridge in the seasons 1950–51 and 1952–53. These two seasons are those in which most of the Mallard have been caught at each station. Inclusion of the smaller catches of other seasons would confuse and not improve the analysis. In Table V these data are converted to sex-ratios, in the form x ♂♂ : 100 ♀♀, omitting or combining those periods in which the numbers of ducks caught were very small. The Slimbridge data show considerable consistency, both in the overall ratio for each year and in the changes from month to month. More males than females are caught in August and September (particularly early in that month, though this is not shown in the tables), but fewer in October and the winter months. At Abberton there is a great difference between the two seasons : 1952–53 is seen to be largely responsible for the appearance of a preponderance of males in the total catch, Table IV. Violent fluctuations during each season are also apparent.

Understanding of the movements producing these changes should be greatly assisted by the information being collected through the National Wildfowl Count (see Atkinson Willes 1953 for an account of methods employed and some illustrative findings) but relevant published data are very meagre. Perhaps the most interesting comparative material is provided by Lebret (1949), from field counts of the sex-ratio of Mallards in Zeeland, the Netherlands, in 1947–48 and 1948–49. These showed a marked preponderance of males from late August to the beginning of November and a steady ratio of about 113 ♂♂ : 100 ♀♀ during the rest of each winter. The disparity between the sexes decreased through the autumn, from about 230 ♂♂ : 100 ♀♀ in August. No great influx of migratory Mallards occurred in Zeeland during the two winters. Lebret attributes the autumn scarcity of females to the wing-moult, since ducks seek cover during this moult, and since the males moult earlier in the summer. He further points out that only *adult* females suffer a wing moult, so that his counts show that in late August at least 50% of the total stock already consists of adult birds.

The sex-ratios in adult and juvenile ducks caught at different times during the autumn provide a simpler approach to the problems discussed by Lebret. The Abberton catch in the autumn of 1952 (Table VI) provides the only set of monthly totals large enough for use in this way. These totals are still too small for much significance to be attached to the numerical values of the sex-ratios. But they indicate clearly enough that no steady downward trend in the preponderance of males, such as Lebret found in the Zeeland counts, occurred at Abberton in 1952. This suggests that the population at Abberton alters in composition during the autumn and winter and that the scarcity of females cannot be ascribed to the wing-moult of adult females.

TABLE VI

Monthly Changes in Age- and Sex-Ratios of newly-caught Mallard at Abberton, Autumn 1952

Month	Autumn 1952						Adults as % Total Catch
	Adults			Juveniles			
	♂♂	♀♀	♂♂ : 100 ♀♀	♂♂	♀♀	♂♂ : 100 ♀♀	
August ..	53	26	204	48	36	133	43
September ..	30	37	81	28	23	122	56
October ..	44	11	400	33	13	254	55
November ..	78	18	434	60	65	92	43
December ..	64	28	229	42	34	134	57
	269	120	224	211	171	123	50

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SUMMARY

Most of the Mallard ringed in Britain since 1949 have been caught at Abberton, Essex, and Slimbridge, Gloucestershire. Analyses of the catches at these stations and the recoveries of ringed ducks so far reported provide evidence on the relative mortality of juveniles and adults, and of males and females.

The conclusion of Höhn (1948), from earlier ringing of Mallard in Britain, that juvenile mortality is greater than adult is confirmed for the ducks ringed at Abberton but not for those ringed at Slimbridge. This disagreement is probably due to differences in the extent of local movements by juveniles and adults and particularly to much heavier shooting pressure in the immediate vicinity of Abberton. Additional evidence is provided for the undesirability of using data from hand-reared ducks in the estimation of mortality rates for wild populations. The difference in juvenile and adult mortality is shown to result principally from casualties in the early autumn.

Males appear to be more vulnerable to shooting than females, but more females than males fall victims to predators and accidents. Casualties of this kind occur mainly from March to July.

The age- and sex-ratios amongst Mallard caught at Abberton and Slimbridge show great variation between the two localities, between different years at each locality and during each autumn, but insufficient data are available to enable these variations to be explained satisfactorily. At Slimbridge more males than females are caught in August and September, but fewer from October to February. At Abberton males are nearly always more plentiful than females. The sex-ratios of adults and juveniles seem to vary independently.

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