British recoveries of Mallard ringed at Borough Fen Decoy, Northamptonshire

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The overseas recoveries of Mallard *Anas platyrhynchos* ringed at Borough Fen Decoy, Northamptonshire, since 1957 were analysed recently (Ogilvie and Cook 1971). This present paper deals with the far more numerous recoveries within the British Isles from the same ringing station. The main approach has been to see whether each season's recoveries can be used to monitor the Mallard population which the ringed sample represents. Particular attention has been paid to seasonal variations in mortality, numbers and local movements. With Automatic Data Processing of recoveries becoming available at the Nature Conservancy's Biological Records Centre, Monks Wood, Huntingdon, it should in future be possible to make annual analyses along the most promising lines indicated in this paper. Thus rather soon after the end of each shooting season it can be discovered what the winter mortality levels have been in relation to the size of the population the previous autumn. Such information should considerably improve our knowledge of the population dynamics of Britain's commonest waterfowl species.

The last analysis of British recoveries of Mallard ringed at Borough Fen Decoy was by Boyd and Ogilvie (1961). They demonstrated that Mallard ringed at the Decoy wandered little during the winter season of ringing, 22% of recoveries being within 10 miles (16 km.) and 90% within an irregular boundary varying between 40 and 80 miles (64 and 128 km.) from the Decoy, and largely following watersheds. A further important finding was that no less than 86% of recoveries in the season after ringing were in this 'dispersion area', further indicating the sedentariness of British-bred Mallard and the adoption of traditional wintering areas by immigrant Mallard from the Continent. This pattern of restricted movements has been confirmed in the present analysis. It has important implications both when discussing the conservation of Mallard and when seeking to use ringing to monitor populations. Results from ringing at Borough Fen do not necessarily apply to other populations within the country.

Materials and methods

The numbers of Mallard ringed at Borough Fen Decoy in each ringing season (July to March) from 1957-58 to 1970-71 are set out in Table I according to month of ringing. It can be seen that within the period the seasonal total has varied from 1,100 to 2,596, and that the principal catching time is from August to November with September predominating. The ratio of males to females in the catch is close to unity. The annual variation in the catch is governed by several factors, some of which, such as breeding success, can be checked (see below). Less easily measurable are local flooding, disturbance of the Decoy by farming activties, availability of natural food in the area, and the weather.

Much of the analysis has been confined to recoveries made by the end of February of the season of ringing (same season recoveries). The shooting season in Britain ends on 20th February on the coast, having closed on 31st January inland. Virtually all recoveries reported

Table I. Numbers of Mallard ringed each month at Borough Fen Decoy, 1957-58 to 1970-71.

Season	*July/Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Jan.*	*Feb./Mar.*	*Total*
1957-58	5	736	102	211	190	73	91	1408
1958-59	78	592	386	341	207	63	75	1742
1959-60	322	1031	548	331	164	105	73	2574
1960-61	133	515	238	67	28	59	39	1079
1961-62	516	479	271	187	65	90	175	1783
1962-63	98	663	257	170	50	0	20	1258
1963-64	223	648	338	170	42	95	75	1591
1964-65	666	1027	454	326	22	26	75	2596
1965-66	413	523	123	17	14	25	27	1142
1966-67	481	986	237	209	108	53	113	2167
1967-68	374	1171	563	278	105	63	65	2619
1968-69	264	554	238	189	51	15	9	1320
1969-70	211	738	193	267	76	53	51	1589
1970-71	219	610	61	98	52	35	25	1100
Totals	4003	10273	3989	2861	1174	755	913	23968

during the open season are from shooting; other causes such as flying accidents amount to less than 2% in most winters.

Same season recovery rates

Birds ringed after the start of the open season (1st September) will be at risk for shorter periods than those ringed before. Ideally only recoveries of birds ringed before the start of the shooting season should be used to provide information on seasonal variation in recovery rates. In this present study, however, the numbers ringed at that time are barely large enough to provide adequate samples of recoveries. Therefore all same season recoveries have been used and a correction factor applied to allow for the date of ringing in relation to the start of the shooting season, following Bellrose and Chase (1950). They used a simple ratio that involved the number of weeks ringed birds were actually available for shooting and the number of weeks that these ringed birds would have been available if they had all been ringed before the start of the shooting season. The correction is made separately for each ringing season.

The first step is to establish the number of ducks ringed in each shooting season (taken as 1st September to 15th February, as the nearest whole number of weeks), and then to find the date by which half the birds have been ringed. This mid-point of the ringing season assumes that all the birds were ringed on that date a known period from the start of the season and from its end. The number of same season recoveries of birds ringed during the shooting season is then multiplied by the ratio (total period of ringing within the shooting season)/(the period from the mid-point of ringing to the end of the season). To this figure is added the number of recoveries from birds ringed before the start of the shooting season, and the whole expressed as a percentage recovery rate of the total ringed.

For this method of correction, the recoveries must be made at a fairly even rate through the shooting season. Somewhat surprisingly the recoveries are indeed made at a remarkably constant rate during the season with no real peak at its start or end. Recoveries made in the second and subsequent seasons after ringing in 1959-60 to 1961-62 are set out in Table II to demonstrate this point.

Table III gives the same season corrected recovery rate for each season together with the data used in calculating them. It can be seen that in every season except 1962-63, when ringing ceased at the onset of severe weather in January, the ringing period lasts 24 weeks, and that in most seasons the mid-point of ringing is very close to the start. This keeps the corrections needed comparatively small (20% or less in ten of the fourteen seasons).

Table II. Distribution of recoveries through the shooting season. Birds ringed 1959-60 to 1961-62 and recovered in 2nd and subsequent seasons.

Month	*Period*	*No. of recoveries*
Sept.	I	18
	II	14
	III	21
	IV	13
Oct.	I	22
	II	11
	III	22
	IV	14
Nov.	I	17
	II	19
	III	17
	IV	14
Dec.	I	15
	II	13
	III	12
	IV	22
Jan.	I	21
	II	17
	III	11
	IV	17 (a)
Feb.	I	5
	II	1
	III	4 (b)
	IV	1

(a) Jan. 31st is end of inland shooting season.
(b) Feb. 20th is end of coastal shooting season.

The most useful way that these same season corrected recovery rates can be applied is to use them to calculate mortality rates. Using the method of Bellrose and Chase (1950) the annual recovery rate is expressed as a percentage of the ultimate total recovery rate. The latter can only be discovered when all recoveries from a season's ringing have been received. Clearly this takes several years and for the most recent years an adjustment must be made to allow for the fact that some birds are not yet dead. However, the birds die so rapidly that after only a few years the great majority of the recoveries have been notified. Table IV sets out the number of recoveries made each season, plus the cumulative percentages, for Mallard ringed in the three seasons 1957-58 to 1959-60. It can safely be assumed that virtually all these recoveries have now been received. By the end of the third season nearly 80% of the recoveries had already been made, and this rose to over 87% by the end of the fourth. Taking these percentages as typi-

Table III. Same season corrected recovery rates, 1957-58 to 1970-71.

Season	*Weeks of ringing from 1 Sept.*	*Weeks from mid-ringing period to 28 Feb.*	*Same season recoveries ringed after 1 Sept.*	*Corrected total*	*Same season recoveries ringed before 1 Sept.*	*Total recoveries*	*Corrected recovery rate (%)*
1957-58	24	21	82	94	0	94	6.8
1958-59	24	18	99	132	5	137	8.0
1959-60	24	19	163	206	29	235	9.2
1960-61	24	21	58	66	10	76	7.1
1961-62	24	19	98	124	47	171	10.0
1962-63	16	13	114	140	6	146	11.8
1963-64	24	20	91	109	24	133	8.5
1964-65	24	20	161	193	68	261	10.3
1965-66	24	22	47	51	38	89	7.9
1966-67	24	21	118	135	50	185	8.7
1967-68	24	20	196	235	44	279	10.7
1968-69	24	20	50	60	12	72	5.5
1969-70	24	20	93	112	15	127	8.2
1970-71	24	22	37	40	21	61	5.6

Table IV. British recoveries of Mallard ringed at Borough Fen Decoy in 1957-58 to 1959-60, and recovered each season since ringing, up to April 1971.

Season	*same*	*2nd*	*3rd*	*4th*	*5th*	*6th*	*7th*	*8th*	*9th*	*10th*	*11th*
No. of recoveries	466	213	92	87	53	29	21	9	3	2	4
Cumulative %	47.5	69.4	78.8	87.7	93.1	96.1	98.2	99.1	99.4	99.6	100.0

cal for the whole period they have been used to adjust the recoveries received from ringing for more recent seasons by adding to the number of recoveries so far made the number to be expected in the future based on this declining rate per annum. Even for quite recent seasons of ringing the adjustment is going to be comparatively small.

The same season and second season mortality rates are displayed in Table V. The figures for same season rates up to and including 1968-69 can be assumed to be quite accurate. The adjustment to 1969-70 is probably too large to be sure of its final correctness, and a figure for 1970-71 would not be meaningful at all. No distinction has been drawn between adult and first year birds. Although the latter are known to have the higher mortality rate, the proportion of adult birds in the ringing totals is low (Table VI), generally less than 10% and only once as high as 19%. There is no correlation between the proportions or actual

Table VI. Breeding success of Mallard indicated by percentage of juveniles caught at Borough Fen Decoy in July to September. Ageing techniques were not developed until 1959-60.

Season	*% juveniles*	*Season*	*% juveniles*
1959-60	93	1965-66	81
1960-61	98	1966-67	95
1961-62	90	1967-68	84
1962-63	86	1968-69	92
1963-64	99	1969-70	95
1964-65	93	1970-71	86

Table V. Season of ringing mortality rates, and rates from previous season's ringing.

	Mortality rates			*Mortality rates*	
Season	*Season of ringing*	*Previous season's ringing*	*Season*	*Season of ringing*	*Previous season's ringing*
1957-58	41.9	—	1964-65	55.4	42.3
1958-59	45.5	40.4	1965-66	50.0	41.0
1959-60	52.2	45.8	1966-67	56.1	45.5
1960-61	41.2	30.8	1967-68	55.6	38.2
1961-62	54.0	44.5	1968-69	39.3	33.0
1962-63	61.8	54.1	1969-70	(56.2)	(43.0)
1963-64	55.5	37.0	1970-71	—	—
			Means (excl. 1969-70)	50.9	41.1

numbers of adults in the ringing totals and the same season mortality rates.

The correlation between the corrected same season recovery rates given in Table III and the same season mortality rates in Table V is very high ($P<.001$); higher indeed than one would have expected even allowing for the large contribution that the same season recovery rates make to the final total. Furthermore the correlation between the same season mortality rates and the mortality rates for birds ringed the previous season (shown in Table V) is also good ($P<.01$). Both correlations add considerable weight to the conclusion that the corrected same season recovery rate is a valid figure and that it is a direct indication of the mortality rate for that season which normally can only be calculated after several more seasons have elapsed. The corrected same season recovery rate which can be calculated shortly after the end of the shooting season is therefore of considerable value as a means of monitoring the mortality of the population.

This direct relationship between recovery rate and mortality rate was first used by Hickey (1952) to discover the natural mortality rate if there were no shooting. Figure 1 plots the two sets of figures for the Borough Fen Mallard. The line drawn through the points on the graph has been extended to the left to where it crosses the vertical axis at about 20%. This figure represents non-shooting mortality, when virtually no recoveries will be made. Crissey (1964) has suggested that such low natural mortality rates indicate that the carrying capacity of a wintering area exceeds that required by present populations. Mortality rates for other species and other populations of Mallard need to be calculated before this could definitely be said to apply to British conditions. It is pertinent to point out that the number of Mallard wintering in Britain has in fact increased by about 30-40% in the period of this study (Atkinson-Willes 1970; Atkinson-Willes and Yarker 1970, 1971).

The mortality rates in Table V exhibit no trends and the range of season of ringing figures is comparatively small with only the very severe winter of 1962-63 showing clearly the increased mortality that was suffered that year. This confirmation of the hard winter effects encourages belief in the reliability of the mortality rates. It will be possible to study future peaks or troughs within a month or so of the end of the shooting season thus greatly increasing the chances of discovering the causes. If a trend in the rates develops it too will be detected earlier.

The mean of the season of ringing mortality rates at 50.9% and the mean

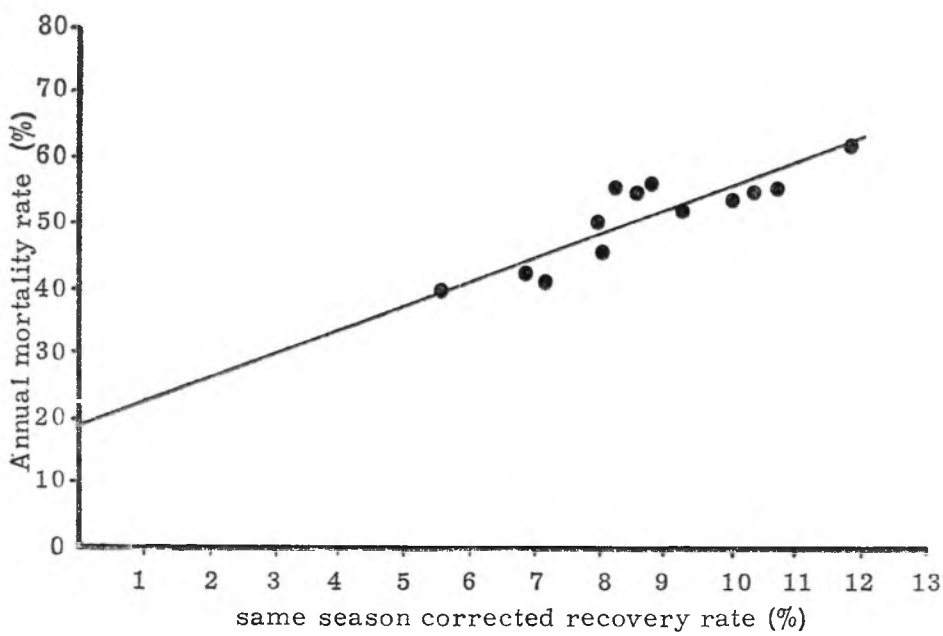

Figure 1. Relationship between recovery rates from shooting and season of ringing mortality rates for Mallard, 1957-58 to 1969-70. The point where the line cuts the vertical axis represents the mortality percentage assuming no shooting.

of the rates from the previous season's ringing at 41.1% can be compared with past calculations. Boyd (1962) found a mean annual mortality rate of 48% for birds recovered after the first 1st January of their life, while Wainwright (1967) excluded all birds in their first year of life and obtained a mean annual mortality rate of 43%. The figures given in Table V are reasonably close to these estimates bearing in mind the different age categories used.

Population size

It would be useful if the size of the decoy catch was related to the size of the population available. The latter is affected among other things by the success of the past breeding season and also by the numbers of foreign immigrants coming in during the autumn and winter. Ogilvie and Cook (1971) attempted to measure the latter but found that only in a few years were there marked influxes and these did not tie in with the numbers being caught late in the season.

Variations in breeding success of British Mallard ought, on the face of it, to be reflected in the proportions of adult and young birds in the catch, particularly in July, August and September. The data are restricted to these months partly to confine the sample to known British birds and partly because as the autumn progresses an increasing number of males become impossible to age. However, there are almost certainly differences in the catchability of adults and young Mallard in a decoy, and the proportions caught in each season (Table VI), although varying to some extent, bear no relationship to the catch size (Table I).

The National Wildfowl Count Scheme run by the Wildfowl Trust monitors the size of the Mallard population wintering in Britain (Atkinson-Willes 1970; Atkinson-Willes and Yarker 1970, 1971; Atkinson Willes and Garvey 1972), but because ringing has shown that British Mallard are subdivided into more or less discrete groups the national indices that have been published are not necessarily closely related to the Mallard numbers around Borough Fen. For this reason an analysis was made of the numbers of Mallard counted on about 40 waters within the dispersion area of the Decoy delimited by Boyd and Ogilvie (1961). This extends up to 80 miles (128 km.) from it. It is sad to have to relate that no sort of correlation could be found between the numbers of Mallard being caught and ringed at Borough Fen Decoy and the numbers counted on various combinations of waters at different distances from the decoy, and that this applied to both between and within season comparisons. The most that could be found was some agreement in the first five years of the study between the number of birds being ringed in September and the number counted in that month, but thereafter the number counted increased fairly steadily while the number being ringed fluctuated in no regular manner.

To some extent the sample of waters being counted is not representative of the waters holding Mallard in the area. Some of the more important Mallard haunts are not adequately counted, usually because of difficulties inherent in the topography, for example of the Wash and the North Norfolk coast. Furthermore the Mallard is the one species of British wildfowl which has a relatively large proportion of its population dispersed over very small waters, including ponds and drainage ditches which of course abound in the Fens. These latter naturally do not warrant coverage by the Wildfowl Count Scheme. Thus, although it would have been useful if some relationship could have been established between the numbers ringed and the population size as measured by the existing wildfowl counts, the fact that it could not is not all that surprising.

Wainwright (1967) and Matthews (1968) have also tried to establish relationships between counts of ducks and the number caught for ringing, at Abberton Reservoir, Essex, and Nacton Decoy, Suffolk, respectively. Wainwright found that there was good agreement between the number of Teal present on the reservoir, a very important haunt for this species, and the number he was catching in his cage traps. Matthews, however, analysing decoy catches of Mallard, Teal and Wigeon found only slight agreement between the Teal catch and national counts, and none with the other species. The correlation seemed to be confined to very good catches in seasons with unusually large numbers of Teal in the country but otherwise little agreement.

The conclusion would therefore seem to be that the population size cannot be measured by that of the catch, and also that the catch size is not affected by variations in the numbers of duck present at any rate within the range experienced in recent years.

Reporting rate check

One very important point to be checked in any ringing programme involving birds with high recovery rates from shooting is

whether the reporting rate declines over a period of years. This would particularly be expected for birds shot close to the ringing station, where the shooter would repeatedly be sending ringing details for the birds that he had shot that differed very little from each other. "Reporter boredom" has then often been recorded, and this affects the quality of the recovery data.

Table VII sets out the same season recoveries of Mallard in three categories of distance from Borough Fen Decoy, up to 10 miles, from 11 to 30 miles, and over 30 miles (16 km., 17 to 48 km., and over 48 km.). These recoveries are then expressed as recovery rates in each season and, further, as proportions of the totals. These convincingly show that there has been no fall off in the proportion of recoveries being reported from close to the decoy and is almost certainly a reflection of the good relationship between the decoyman and the local wildfowlers, who have been made aware that every recovery is of value even though the information relating to it may look rather uninterestingly familiar.

Table VII. Reporting rate check.

Season of recovery	*Number ringed*	*Same season recoveries*			*Recovery rates (%)*			*% at different distances*		
		<10 m.	*11-30*	*>30*	*<10 m.*	*11-30*	*>30*	*<10 m.*	*11-30*	*>30*
1957-58	1408	20	39	23	1.4	2.8	1.6	24	48	28
1958-59	1742	23	42	39	1.3	2.4	2.2	22	40	38
1959-60	2574	28	76	88	1.1	2.9	3.4	15	40	45
1960-61	1079	15	16	37	1.4	1.5	3.4	22	24	54
1961-62	1783	35	58	52	2.0	3.3	2.9	24	40	36
1962-63	1258	38	39	43	3.0	3.1	3.4	32	32	36
1963-64	1591	27	50	38	1.7	3.1	2.4	23	44	37
1964-65	2596	59	76	94	2.3	2.9	3.6	26	33	41
1965-66	1142	24	36	25	2.1	3.1	2.2	28	42	30
1966-67	2167	63	50	55	2.9	2.3	2.5	37	30	33
1967-68	2619	66	98	76	2.5	3.7	2.9	27	41	32
1968-69	1320	26	15	21	2.0	1.1	1.6	42	24	34
1969-70	1589	36	26	46	2.3	1.6	2.9	33	24	43
1970-71	1100	22	34	38	2.0	3.1	2.5	26	41	33
Totals and means	23968	482	655	665	2.0	2.7	2.8	27	36	37

Local movements

Borough Fen Decoy is situated near the south-western corner of the extensive Fens, flat rich farmland dissected by innumerable drainage ditches, and about fifty kilometres from the south shore of the Wash. The nearest permanent standing water is at some large gravel pits between three and four kilometres to the north-west; winter floodwater could be found regularly until about 1963, but only occasionally since, in the Nene Washes about 12 kilometres south-east. Further afield most of the wetlands are to the north and east, including the Wash, the Ouse Washes and north Norfolk. As might be expected, the larger part of the recoveries come from these areas. However, significant numbers do move in other directions, and the overall picture is set out in Figure 2. The figures represent the percentages in each of the four directions for each distance category from the ringing station. The directions of recovery have been grouped around north and north-east, east and south-east, south and south-west, and west and north-west. Directional differences between seasons were generally slight, and it was not possible to find any relationship between the percentage recovered in different directions and distances and the seasonal mortality rates. It can be concluded that the latter are not dependent upon shooting in any one or two particular areas.

Conclusions

The present scale of ringing at Borough Fen Decoy produces between 62 and 240 same season recoveries per season. A level of 200 recoveries per annum was regarded as a reasonable target by Matthews (1966). This applied to all recoveries not just same season, which would amount to about half of these (see Table IV). In only eight of the fourteen seasons now being considered were there as many as 100 same season recoveries. In order to achieve this number of recoveries, between 1,500 and 1,700 Mallard should be ringed each season. There is thus no reason to consider a reduction in the present ringing of Mallard at Borough Fen Decoy, rather the opposite, if sufficient recoveries are to be received for annual analyses along the lines given in this paper to be made. This was also our conclusion (Ogilvie and Cook 1971) following the analysis of foreign recoveries of Mallard.

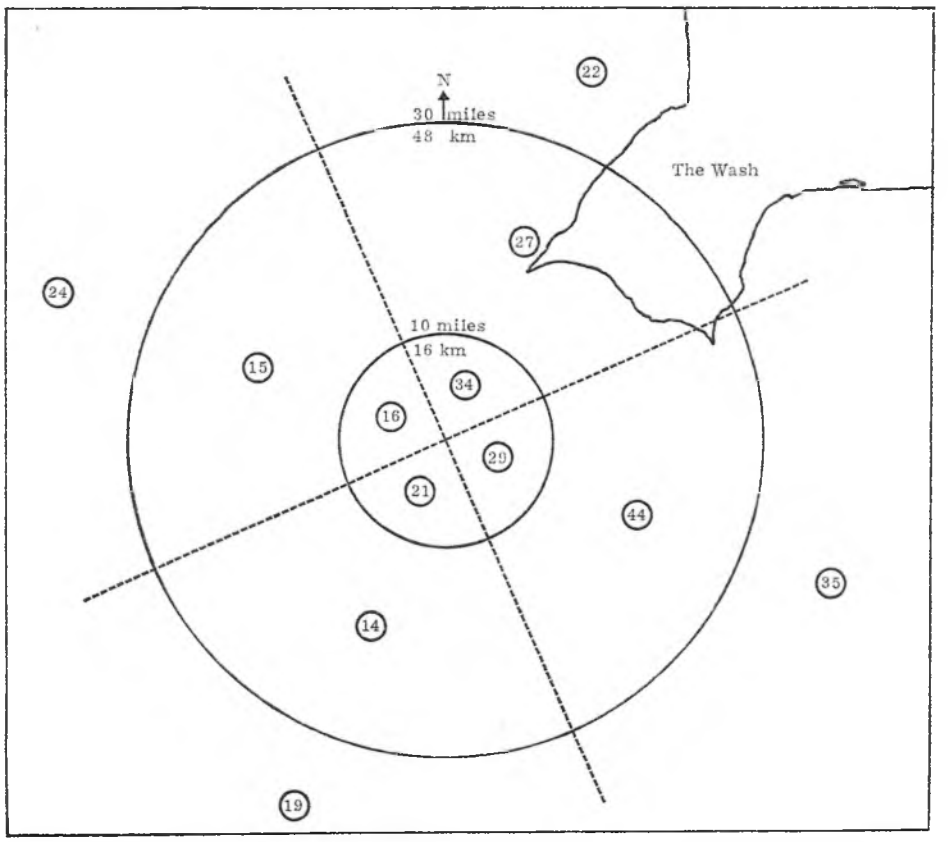

Figure 2. Distance and direction from Borough Fen Decoy of same season recoveries of Mallard. Figures are percentages for each distance category.

The distribution of ringing through the season is anything but even, with a great preponderance being done in September. It would be preferable if the numbers ringed in each month could be made more equal but catching of Mallard in a duck decoy is not so easy to adapt. If the catch for any single month or shorter period is pegged to a predetermined ceiling, it may be found that catching falls off completely later in the same season and the necessary minimum total for the season may not be reached at all. With the requirement for a certain minimum number of recoveries each season, it is necessary to set any early season catch limits as high as possible, if they are to be set at all. On the basis of the last fourteen seasons the number in which a more than adequate sample has been ringed was far exceeded by those in which the catch has been insufficient.

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Summary

British recoveries of Mallard *Anas platyrhynchos* ringed at Borough Fen Decoy, Northamptonshire, have been analysed. A corrected same season recovery rate is used to calculate season of ringing mortality rates which form an effective way of monitoring annual variations immediately after the end of each shooting season. The natural mortality rate for this population of Mallard, if there were no shooting, would be about 20% per annum. The season of ringing mortality rate has varied between 39.3% and 61.8%, the latter in the severe winter of 1962-63. The number of birds ringed each season does not seem to have any relationship with the annual breeding success as measured by the percentage of adults in the catch, or with the size of the population measured by counts on waters within 80 miles (128 km.) of Borough Fen. There has not been any falling off in the reporting rate of recoveries, even close to the ringing station. The distribution of recoveries round the Decoy follows topographical features favourable to Mallard. The present scale of Mallard ringing at the Decoy is only just adequate to provide the necessary number of recoveries for annual analysis.

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