RECENT POPULATION CHANGES IN BRITISH DUCKS

S. K. Eltringham and G. L. Atkinson-Willes

Summary

A method is described of obtaining indices to represent the relative abundance of ducks in the same month of different years and in each season as a whole. Results are based on the sample which has been used since September 1959 to produce monthly reports for observers in the National Wildfowl Count Scheme. The species investigated are Tufted Duck, Pochard, Mallard, Teal and Wigeon, and the months under consideration September to March inclusive. The period covered is from autumn 1948 to spring 1960.

The Tufted Duck in Great Britain has shown an average annual increase of about 8½% and has doubled its winter population within the period under review. This rate of increase agrees well with two other estimates; one based on an unpublished study of the survival of ringed adults and of breeding success in England during the period 1949-1957. the other on the results of a survey made in the London area between 1950 and 1957. The monthly indices also agree with those obtained by a different method from a much larger sample of Wildfowl Counts.

The increase in Pochard wintering in this country is equivalent to an annual rise of nearly 5% over the full twelve years. The whole of this, however, took place in the three years 1951-1954, and there has been no significant change since.

Of the other species, Mallard increased steadily at an annual rate of about 2½%; Wigeon showed no significant trend; and neither did Teal, although in 1959-60 an unusually large influx occurred. By comparison with previous analyses it seems that the number of Mallard in October 1959 was exceptional. and that the bulk of the Teal entered and left this country about a month earlier than usual.

Introduction

The analysis of data acquired by the Wildfowl Trust under the National Wildfowl Count Scheme has always suffered from a lack of continuity in the observations, and probably always will. In the past this difficulty was met by interpolation of the missing counts (Atkinson-Willes 1955, 1957) but such estimates, however well-informed, were bound to form a source of potential error. An alternative was to restrict the sample to those waters for which an unbroken series of counts was available, but this so reduced the data that comparisons were limited to a very few years. A new technique, however, has now been evolved making it possible to trace with confidence the trend in the British duck population over the twelve years 1948-1960. The following is the procedure adopted.

1. A standard or master year is selected from the seasons under review, for preference the one in which the data are most complete. In the present study the season of 1959/60 has been chosen for the purpose.

2. The counts for each month of the master year are in turn compared with the data from the corresponding months in each of the other years. All waters which were counted in both the master and the paired month are included in the sample, and the numbers of ducks present on each occasion are summed to give two directly comparable totals. These individual samples vary, however, both in size and composition, according to the data available, so that direct comparisons between all years are not, at this stage, possible.

3. To overcome this, the numbers of ducks in the other years are expressed as percentages of the number present in the master year. These percentages can be used as indices to show the relative abundance of a species month by month in all the years under review. By definition the population in the master year will always have a value of 100.

Example: To compare the number of ducks present in September of 1952, 1956 and 1959 (1959 being the master year)

1. A sample of 52 waters held 9000 ducks on 10.9.52 and 10,000 on 15.9.59.
2. A sample of 74 waters held 12,000 ducks on 20.9.56 and 16,000 on 15.9.59.

Therefore:

The waters in pair 1 held 90 ducks in 1952 for every 100 in 1959 and the waters in pair 2 held 75 ducks in 1956 for every 100 in 1959

The relative numbers of ducks in September of the three seasons was thus 90, 75 and 100 respectively.

4. This comparison between months is only the first stage; the method can now be extended to provide a seasonal index, showing the relative abundance of a species over the winter as a whole. These seasonal indices are derived from the data on which the monthly indices are based; for each season the actual numbers of ducks in all the paired months are summed to give two comparable totals. These totals are then expressed as percentages of those in the master season. The advantage of this method is that due weight is given to the months when the ducks are most plentiful; a big relative increase in mid-winter, when thousands of birds are present, is clearly much more important than a similar increase in early autumn, when there may be only a few hundred. It also takes into account the length of time during which large concentrations are present.

As yet no suitable statistical method has been devised to test the reliability of either the monthly or the seasonal indices, but since this is likely to increase with sample size, more weight should be attached to the results of later years. The seasonal index depends upon the differing sampling intensities each month and if these differ, a bias will be introduced. In the present work, the sampling was of a comparable intensity each month, and it is unlikely that the errors introduced by such bias are large.

In the present study five of the commonest British ducks, namely Mallard *Anas platyrhynchos*, Teal *A. crecca*, Wigeon *A. penelope*, Pochard *Aythya ferina* and Tufted Duck *A. fuligula*, have been selected for investigation; the data being derived from counts made on about a quarter of the 600 or more waters which are covered by the Wildfowl Count Scheme. The sample has been specially chosen to include those waters on which the majority of the counted ducks is found. To qualify for inclusion a water has to carry a regular peak of either 750 Wigeon, 500 Mallard, 300 Teal, 200 Pochard or 200 Tufted Duck. This sliding scale reduces the sample of waters to 174. From these, the samples for the individual species are assembled; in the final lists Mallard are represented on 161 waters, Teal on 118, Wigeon on 113, Pochard on 51 and Tufted Duck on 80. In practice, not more than three-quarters of the waters concerned were visited in any one month during 1959-60 so that the actual samples used were always much smaller. A map of the distribution of the 174 places is given in Figure 1.

Results

Each species is considered separately in the following results. At the head of each section there is a table showing the monthly indices in each year since the counts began. This is followed by a graph showing the annual indices

Figure 1. Distribution of places where ducks were counted.

which are derived from the data in the Appendix. The significance of any trends in the annual indices has been tested statistically. When the value of the correlation coefficient justifies its use, the regression of the indices upon the years has been drawn in and used to measure the annual rate of increase in the population.

Tufted Duck *Aythya fuligula*

	1948 –49	1949 –50	1950 –51	1951 –52	1952 –53	1953 –54	1954 –55	1955 –56	1956 –57	1957 –58	1958 –59	1959 –60
September ..	—	54	35	58	69	120	60	73	78	116	103	100
October ..	38	20	15	47	26	28	45	44	61	54	72	100
November ..	67	48	59	—	74	56	84	86	82	124	92	100
December ..	—	75	74	88	107	78	106	107	123	144	101	100
January ..	61	56	88	64	64	70	70	72	92	84	67	100
February ..	—	56	115	51	88	85	93	126	86	106	96	100
March	86	53	87	85	89	79	95	105	103	114	111	100

Table 1: Monthly indices to show the relative abundance of Tufted Ducks on varying samples of waters. The figures show the number of birds present in the earlier years for every 100 present in 1959-60.

It is obvious from the annual indices (Figure 2) that there has been a considerable increase in the Tufted Duck population since 1948-49. Calculation of the correlation coefficient shows that the upward trend is highly significant ($P<0.001$). The regression line has therefore been included

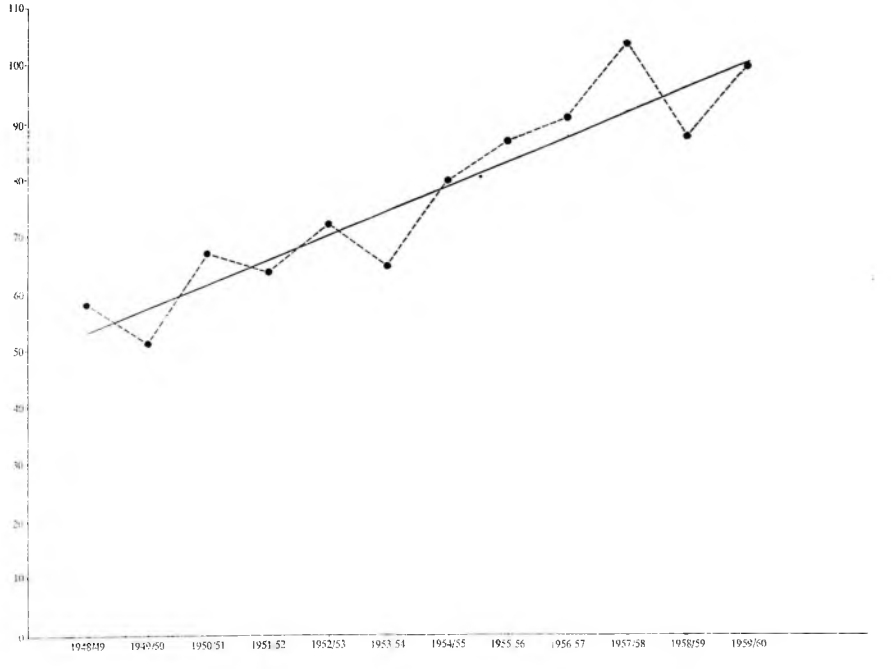

Figure 2. Seasonal indices for Tufted Duck, 1948 to 1960. The fitted regression line corresponds to an average annual rate of increase of about 8½%.

in the figure and used to estimate the annual rate of increase. This amounts to about $8\frac{1}{2}\%$, a very high rate which, if maintained, will continue to double the population every 12 years. The increase has been remarkably steady throughout the period and shows no definite signs of levelling out.

This same spectacular rise has been found by other workers. In a review of duck counts in the London area, Homes (1958) gives figures for the Tufted Duck for eight of the ten seasons between 1947 and 1957. These are based on the average of a variable number of acceptable monthly counts between October and April. Over 30 waters were considered and the peak

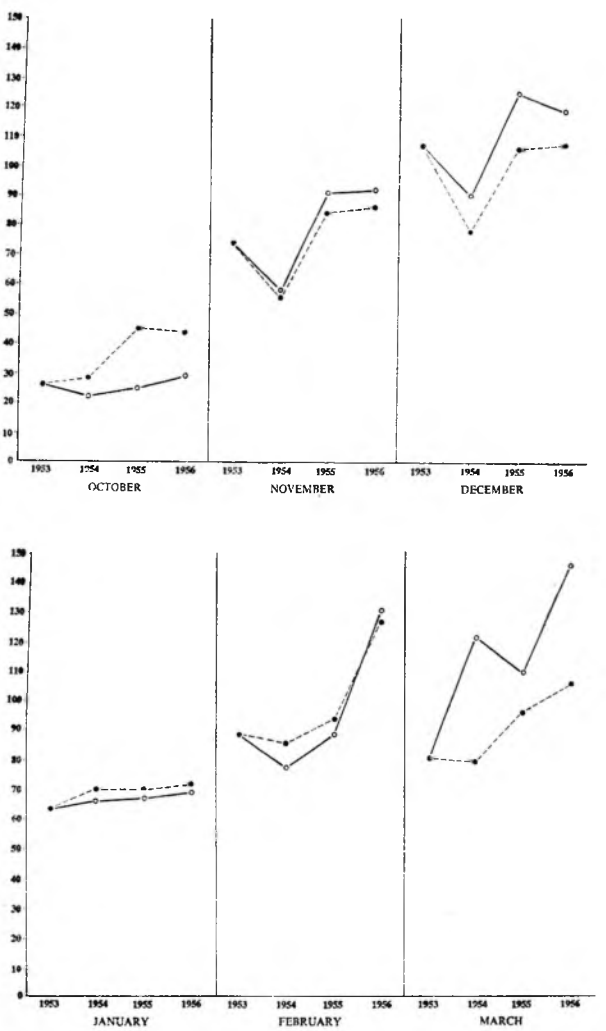

Figure 3. Comparison of the monthly indices obtained in this study with those from a larger number of waters in the seasons 1952 to 1956. Open circles joined by solid lines show indices obtained in this study, closed circles joined by broken lines those obtained by Atkinson-Willes (1957).

number of ducks each year varied from 2,328 to 5,186. A statistical test on these data again shows a highly significant upward trend amounting to an annual rate of increase of nearly 10%.

An independent estimate of the rate of increase has been given by Boyd in an unpublished study made in 1958 of the survival of ringed adults and of breeding success in England. His figure for the annual increase is just over 8½% for the period 1949-1956. A similar trend in the population of the Tufted Duck in the years 1947 to 1954 is also shown in the work of von Haartman (1957) who reports a breeding survey in the S.W. archipelago of Finland between 1935 and 1955.

Atkinson-Willes (1957) in a previous analysis of a much larger sample concluded that the Tufted Duck population level had been steady over the six years 1950-55. This conclusion was based largely on the monthly indices for January, the month in which the numbers were assumed to be most stable. Nevertheless, a trend is discernible in his figures, although not obvious because of the shorter period considered.

These results of Atkinson-Willes can also be used to test the validity of the present method on a restricted sample. He used a somewhat different technique in that comparisons were made not with a single master year but with an average, defined from the results of three consecutive seasons. In Figure 3 the results of the two analyses have been reduced to a common base so that a direct comparison can be made between them. In the earlier study the four year run from 1952 to 1956 provides a sample of 295 waters; it was thus about 5½ times as large as the present one, although it dealt with only twice as many ducks. The trends shown by the two sets of figures are remarkably similar, especially in the mid-winter months when the species is most numerous. The discrepancies in October and March are no doubt due to a dispersal at these times on to the small waters excluded from the present sample. Apart from this, the comparison suggests that the present analysis of counts from fifty or so waters provides results which are at least as reliable as those derived from a sample of nearly 300.

Pochard *Aythya ferina*

	1948 –49	1949 –50	1950 –51	1951 –52	1952 –53	1953 –54	1954 –55	1955 –56	1956 –57	1957 –58	1958 –59	1959 –60
September ..	—	35	21	36	64	41	53	60	32	168	88	100
October ..	102	65	49	82	210	88	110	101	126	115	103	100
November ..	70	74	84	—	136	63	107	109	138	127	141	100
December ..	—	62	63	65	129	56	114	86	87	82	98	100
January ..	73	59	87	73	65	68	111	87	92	57	75	100
February ..	—	43	105	68	90	72	80	97	70	72	85	100
March	24	30	79	24	37	62	63	92	69	50	70	100

Table 2: Monthly indices showing the relative abundance of Pochard on varying samples of waters.

In the case of Pochard the annual indices (Figure 4) show two distinct levels of population, separated by a period of violent fluctuation between 1951 and 1954. Taken over the full twelve years, the increase, which is

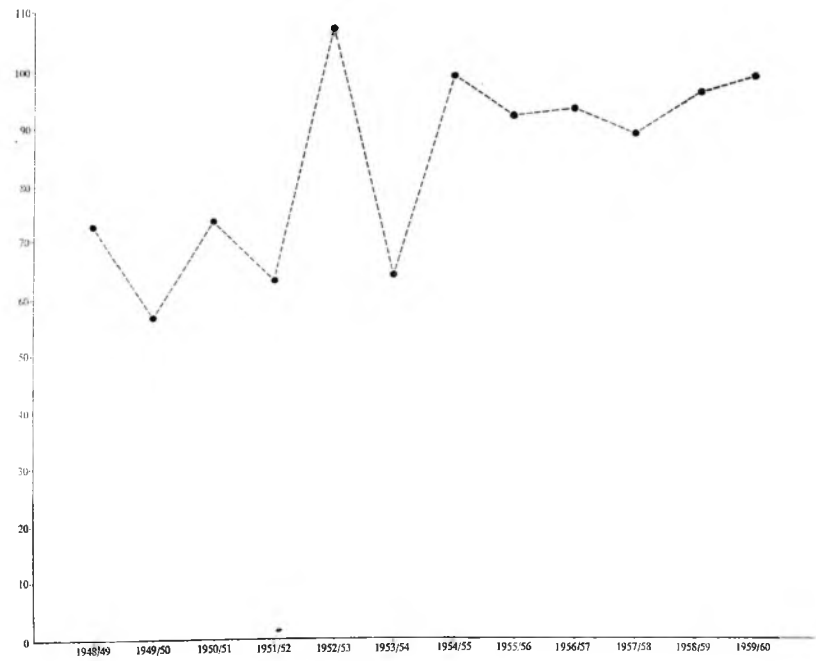

Figure 4. Seasonal indices for Pochard, 1948 to 1960. Population steady since 1954 at a level some 50% above that prior to 1951.

significant ($0.02>P>0.01$), represents an annual gain of nearly 5%, but this is clearly unrealistic. A better interpretation is that the population has remained steady since 1954 at a level some 50% higher than it was prior to 1951.

Mallard *Anas platyrhynchos*

	1948 –49	1949 –50	1950 –51	1951 –52	1952 –53	1953 –54	1954 –55	1955 –56	1956 –57	1957 –58	1958 –59	1959 –60
September ..	—	48	54	58	101	68	66	61	68	75	74	100
October ..	68	53	53	64	61	58	49	67	49	74	56	100
November ..	49	81	83	—	78	69	90	85	91	84	88	100
December ..	—	77	92	97	95	93	87	91	101	94	78	100
January ..	63	76	100	77	77	60	82	72	72	73	81	100
February ..	—	89	98	67	85	88	92	101	95	102	79	100
March	108	63	102	64	96	99	92	117	59	114	88	100

Table 3: Monthly indices showing the relative abundance of Mallard on varying samples of waters.

The apparent increase of Mallard shown in Figure 5 is significant ($0.01>P>0.001$) and amounts to an annual gain of about 2.5%. The most striking feature, however, is the high level of the 1959/60 index, which results from a big increase in the autumn numbers. At that time the counts were almost twice as large as usual, although by February they had returned to normal. This seems to have been due partly to an exceptionally good breeding season in England (Boyd and King 1960) and partly to an unusually early immigration from the Continent.

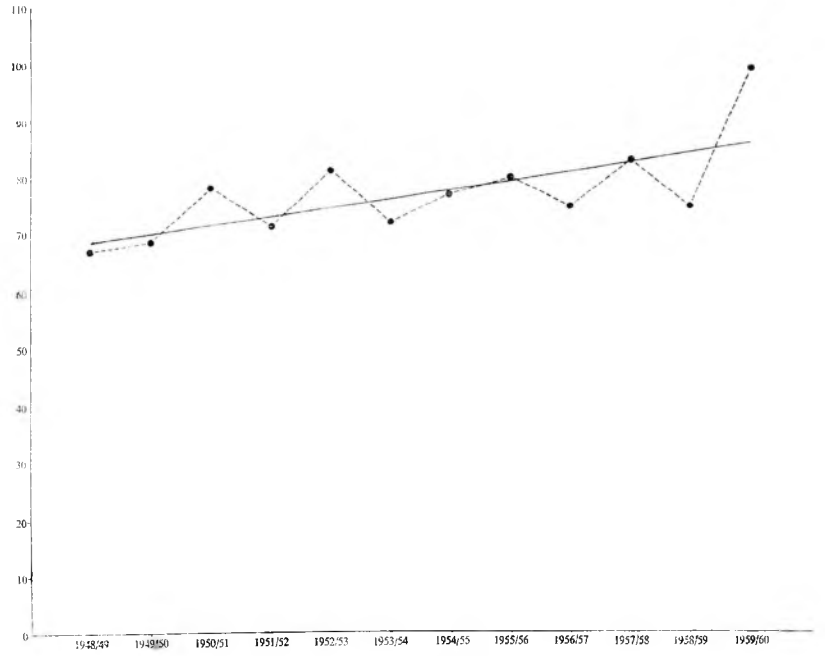

Figure 5. Seasonal indices for Mallard, 1948 to 1960. The fitted regression line corresponds to an annual rate of increase of about 2½%.

Teal *Anas crecca*

	1948 –49	1949 –50	1950 –51	1951 –52	1952 –53	1953 –54	1954 –55	1955 –56	1956 –57	1957 –58	1958 –59	1959 –60
September ..	—	18	32	23	31	16	26	31	24	40	20	100
October ..	34	49	30	25	46	30	26	50	35	59	41	100
November ..	68	19	47	—	32	35	55	69	54	65	23	100
December ..	—	18	36	24	40	27	39	48	54	65	24	100
January ..	44	60	121	73	71	88	120	160	68	73	87	100
February ..	—	135	184	95	76	97	118	102	79	101	107	100
March	304	216	245	64	114	142	168	125	156	89	77	100

Table 4: Monthly indices showing the relative abundance of Teal on varying samples of waters.

The monthly indices for Teal show a pattern similar to that revealed by the Mallard figures. In this case the influx is known to have started as early as July 1959 and by September numbers were from two to five times higher than in previous years. This ascendancy was maintained until December, but thereafter the indices fell steadily to an unusually low level in March. This shift in the seasonal movements of the species may have been due to the same factors which caused the early immigration of Mallard. Thus in September the bulk of the population was concentrated in Essex but afterwards the increase was evenly distributed throughout the country. The influx may also have been swollen by birds which normally winter elsewhere. This second suggestion is supported by the recent recoveries (Leach 1960) in this country of Teal ringed in the Camargue, southern France, during previous winters. Prior to the autumn of 1959 no Camargue-ringed Teal had been reported in Britain.

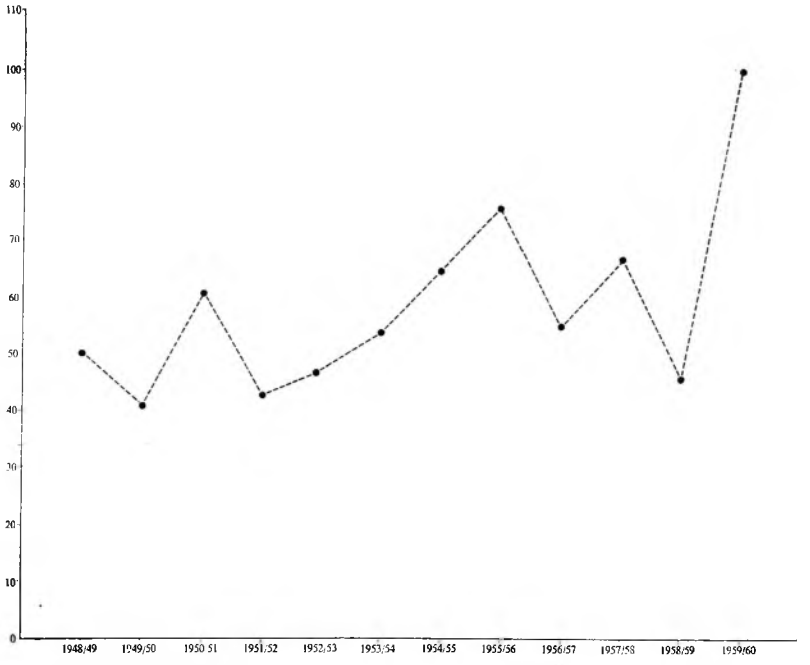

Figure 6. Seasonal indices for Teal, 1948 to 1960. No significant trend in numbers over the whole period.

In the annual indices (Figure 6) an upward trend is just significant ($0.05>P>0.02$). This, however, is due almost entirely to the abnormally high value of the index for 1959-60; the previous years show no significant increase. No attempt is therefore made to assess an annual rate of increase for the twelve year period.

Wigeon *Anas penelope*

	1948 –49	1949 –50	1950 –51	1951 –52	1952 –53	1953 –54	1954 –55	1955 –56	1956 –57	1957 –58	1958 –59	1959 –60
October ..	88	115	82	140	102	74	111	91	72	115	67	100
November ..	108	119	115	—	93	69	144	132	102	115	76	100
December ..	—	92	61	63	72	81	81	80	81	91	53	100
January ..	117	78	83	65	109	115	130	121	74	121	75	100
February ..	—	128	152	70	123	155	226	184	91	115	97	100
March	159	82	94	72	90	123	124	151	41	109	60	100

Table 5: Monthly indices showing the relative abundance of Wigeon on varying samples of waters. Numbers in September are too small to allow comparison.

The annual indices for Wigeon (Figure 7) are evenly distributed around the 1959-60 value, and a statistical test shows that there has been no significant trend in the population over the past twelve years. Throughout the winter of 1959-60 the population remained at an unexceptional level except in December when numbers were well above average. During this month some very large concentrations were reported, including one of 13,500

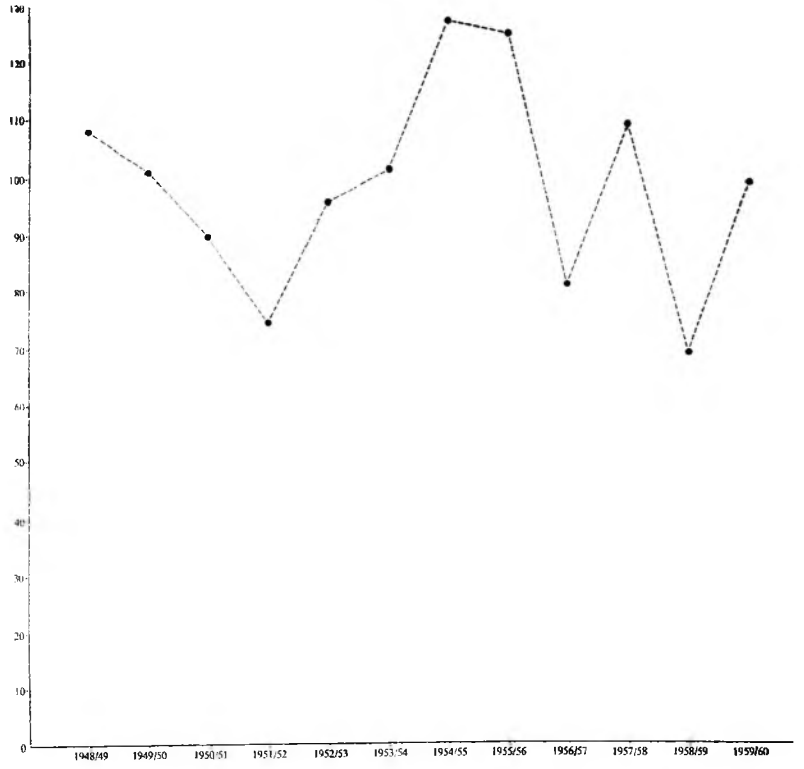

Figure 7. Seasonal indices for Wigeon, 1948 to 1960. No significant trend in numbers over the whole period.

in a single Essex estuary. The late winter decline was most marked in the west of England where numbers were well down for February and March.

Conclusions

The present method of using wildfowl count data to assess trends in populations is the only practical one that has yet been devised. It is simple to use and depends on only one assumption—that a representative portion of the population is sampled on each occasion. This however is unlikely to be a serious source of error; for the present sample already includes the bulk of the resorts known to carry large concentrations of wildfowl.

The results are reassuring from the conservation standpoint; of the five sporting species under review none has decreased since 1948 and in three cases a significant increase has been detected. This is most noticeable with Tufted Duck and Pochard although in the latter instance there has been no important change over the past six years. Increases in the Mallard population have been regular but at a lower rate. Neither Teal nor Wigeon show any significant trend in population during the twelve years under review, although in the case of Teal there is an apparent upward trend, due to the occurrence of quite exceptional numbers during 1959-60. This influx may possibly mark a change to a new population level, similar to that seen in the Pochard in

1951, but more probably the season was an aberrant one. Rather wide fluctuations in the Wigeon indices are probably due to a smaller proportion of the population being sampled than is the case with other species.

Acknowledgements

We are greatly indebted to the many wildfowl counters who, over the past twelve years, have provided the basic data for this paper. We should also like to thank Mr. J. G. Skellam and Mr. M. D. Mountford of the Nature Conservancy for many helpful suggestions.

1960-61

The results of the 1960/61 season have been completed since this paper went to press:

Species	Number in 1959/60	Number in 1960/61	Seasonal Index
Tufted Duck	30,662	30,969	101
Pochard	22,322	27,544	123
Mallard	198,580	167,131	84
Teal	109,045	63,041	58
Wigeon	198,557	191,908	97

The most interesting results are those of Pochard and Teal. The Pochard index has increased by almost a quarter and may presage a further rise in the population level. The Teal index has fallen considerably and is now of the same order as the indices for previous years. This result tends to confirm the hypothesis that the 1959/60 season was an aberrant one for Teal.

References

ATKINSON-WILLES, G. 1955. *National Wildfowl Counts* 1954-1955. Pp 20. Bailey, Dursley.

ATKINSON-WILLES, G. L. 1957. Fluctuations in the winter population of Tufted Ducks in Great Britain. *National Wildfowl Counts Fourth Report*. Pp. 20. Bailey, Dursley.

BOYD, H. & B. KING. 1960. A breeding population of the Mallard. *Wildfowl Trust Eleventh Ann. Report* : 137-43.

HAARTMANN, L. von 1957. Population changes in the Tufted Duck, Aythya fuligula (L.). *Comment. biol.* 16(5) : 1-11. Helsingfors.

HOMES, R. C. 1958. A ten-year review of duck counts in the London area. *London Bird Report* 22, for 1957 : 36-49.

LEACH, E. P. 1960. Recoveries in Great Britain and Ireland of birds ringed abroad. *British Birds* 53 : 502-12.

Appendix

Tabular record of numbers of ducks counted which were used to calculate monthly and seasonal indices.

Table A1: Dates on which Wildfowl Counts used in this analysis were made, 1948-1960.

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
January	—	29	15	7	27	18	3	23	15	27	19	18	17
February	—	—	19	4	24	15	7	20	12	24	16	15	14
March	—	5	19	4	23	15	7	20	11	24	16	15	13
September	—	25	10	30	21	6	26	18	2	22	14	13	—
October	30	23	8	28	19	11	24	16	7	20	12	18	—
November	27	20	12	—	16	8	21	13	4	24	16	15	—
December	—	18	10	2	14	6	19	11	2	22	14	13	—

Table A2: Numbers of ducks counted in 1948-1960 used in calculating monthly and seasonal indices, with numbers of waters visited. " Slave years " compared with 1959-60 as " master year."

(a) **Tufted Duck**

		1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
September	waters ..	—	18	15	18	21	21	26	28	30	33	28	34
	slave ..	—	544	355	554	833	898	1017	1263	1117	2290	1400	—
	master ..	—	1015	1016	961	1198	750	1684	1739	1423	1979	1357	2148
October	waters ..	28	27	30	30	29	38	33	39	37	46	44	54
	slave ..	1575	788	607	1912	1000	1371	1911	2241	2612	2787	3837	—
	master ..	4122	3862	3989	4082	3784	4919	4207	5111	4282	5156	5334	5620
November	waters ..	19	27	30	—	32	38	41	45	43	50	47	58
	slave ..	1048	1544	1938	—	2913	2460	3879	4399	4135	5823	3945	—
	master ..	1563	3214	3301	—	3930	4388	4630	5093	5029	4696	4281	5685
December	waters ..	—	33	31	37	30	35	45	39	44	55	47	58
	slave ..	—	2656	2340	2779	3570	3119	5196	4685	6121	7465	4738	—
	master ..	—	3524	3169	3173	3324	4020	4897	4366	4978	5172	4705	5483

		1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
January	waters ..	31	38	25	31	37	42	41	48	51	46	52	62
	slave ..	2396	3136	4089	3422	3815	4196	4558	4923	5876	4634	4214	—
	master ..	3905	5632	4669	5364	6004	5979	6537	6819	6364	5491	6333	7541
February	waters ..	—	30	18	36	37	32	35	41	44	52	43	56
	slave ..	—	2292	2549	2167	3892	3248	4324	6322	4387	5595	4005	—
	master ..	—	4199	2213	4208	4438	3843	4654	5028	5084	5262	4174	5567
March	waters ..	21	30	23	35	36	36	42	44	42	47	49	54
	slave ..	1556	1145	1462	1897	2137	2072	3222	3724	3482	3741	3791	—
	master ..	1807	2180	1688	2230	2676	2617	3375	3549	3384	3273	3421	3806

Table A2 (continued):

(b) **Pochard**

		1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
September	waters ..	—	12	13	15	18	17	20	22	23	25	22	27
	slave ..	—	414	242	453	841	510	702	868	436	2538	1321	—
	master ..	—	1178	1170	1249	1308	1253	1321	1437	1366	1506	1497	1516
October	waters ..	17	16	18	20	24	27	23	32	29	33	33	38
	slave ..	1585	1030	669	1751	4871	2058	2262	2676	3480	3272	2917	—
	master ..	1561	1577	1358	2133	2314	2327	2059	2642	2754	2856	2835	3185
November	waters ..	8	17	18	—	26	28	29	34	33	31	28	39
	slave ..	1239	1954	2238	—	4334	2070	4272	4960	5607	5550	6129	—
	master ..	1761	2623	2678	—	3193	3279	4003	4540	4063	4383	4347	4852
December	waters ..	—	17	18	21	25	25	29	28	31	33	30	36
	slave ..	—	2220	2121	2633	4140	2481	5597	4189	4464	4247	5028	—
	master ..	—	3566	3340	4047	3211	4395	4927	4842	5133	5173	5102	6135
		1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
January	waters ..	19	22	19	23	28	29	29	33	33	31	33	40
	slave ..	2242	2229	2775	2679	2716	3030	4920	4577	4598	2859	3979	—
	master ..	3089	3769	3181	3655	4169	4481	4434	5272	4996	4977	5312	5765
February	waters ..	—	18	14	25	26	26	29	33	31	36	32	38
	slave ..	—	881	2033	1439	2208	1790	2240	3205	2504	2663	2898	—
	master ..	—	2067	1938	2112	2444	2474	2815	3300	3575	3707	3412	3832
March	waters ..	12	16	16	19	24	21	27	31	29	29	30	35
	slave ..	236	326	961	275	624	879	1051	1743	1206	847	1282	—
	master ..	963	1085	1220	1134	1690	1420	1673	1899	1743	1704	1842	1938

Table A2 (continued):

(c) Mallard

		1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
September	waters ..	—	35	33	35	46	43	51	57	62	64	59	85
	slave ..	—	6945	8424	8743	17782	11025	14081	15202	13751	19338	16175	—
	master ..	—	14421	15615	15029	17536	16102	21215	24796	20252	25703	21913	27556
October	waters ..	42	41	46	60	58	63	66	77	71	79	80	105
	slave ..	8434	9894	10772	18370	17780	17842	15802	25999	17544	29512	20338	—
	master ..	12453	18645	20467	28769	29029	30613	32368	38893	35592	39941	36453	46164
November	waters ..	24	37	46	—	59	73	75	88	73	85	81	114
	slave ..	3510	11129	14004	—	17554	18767	28492	29599	25112	28182	28068	—
	master ..	6451	13767	16956	—	22391	27372	31536	34903	27673	33667	31894	42086
December	waters ..	—	44	50	66	60	67	82	78	78	89	76	109
	slave ..	—	11469	16804	21924	18144	20893	26441	26638	28011	32226	22151	—
	master ..	—	14838	18169	22632	19080	22407	30437	29411	27813	34193	28364	42216
		1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
January	waters ..	41	53	44	62	71	60	82	72	72	73	81	116
	slave ..	9209	14271	14179	17675	19079	19065	22488	23096	25182	25406	28196	—
	master ..	14686	18792	14170	23025	24744	31549	27385	31903	35001	34760	34952	42383
February	waters ..	—	41	33	64	63	66	67	76	78	88	79	104
	slave ..	—	9872	8622	12630	14497	16804	17986	21998	17697	24062	18742	—
	master ..	—	11062	8829	18971	17139	19176	19498	21753	18687	23473	23812	28736
March	waters ..	30	44	42	62	68	66	71	78	71	78	80	102
	slave ..	3642	3547	6095	5429	9310	9778	10538	13772	5492	12567	10345	—
	master ..	3383	5595	5969	8508	9738	9901	11433	11714	9348	10985	11782	15565

Table A2 (continued):

(d) Teal

		1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
September	waters ..	—	21	21	27	33	32	37	39	41	44	44	55
	slave ..	—	1669	2807	2144	2865	1609	2662	3288	2523	4221	2216	—
	master ..	—	9015	8630	9228	9252	9839	10188	10565	10653	10500	10782	11488
October	waters ..	23	26	26	44	47	48	49	59	53	54	59	75
	slave ..	1164	5571	3371	3630	7041	4681	3944	7925	5581	9241	6767	—
	master ..	3416	11280	11352	14696	15198	15596	14897	15890	15703	15741	16614	17403
November	waters ..	14	26	27	—	45	52	51	60	56	59	59	79
	slave ..	1434	2487	6051	—	5911	6902	10964	13952	10611	12810	4567	—
	master ..	2110	12909	12939	—	18621	19737	19841	20163	19597	19774	19953	22624
December	waters ..	—	31	33	45	46	52	60	57	60	58	55	75
	slave ..	—	3174	6447	5381	9105	6828	10347	12757	14164	17190	6265	—
	master ..	—	17217	17707	22358	22743	25030	26435	26326	26315	26346	25574	28418
		1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
January	waters ..	26	36	33	51	55	58	60	67	62	62	64	83
	slave ..	3581	5433	10945	8985	8758	11660	16922	22716	9930	10119	12240	—
	master ..	8198	9064	9011	12345	12293	13215	14068	14269	14567	13849	14036	16540
February	waters ..	—	30	26	52	47	57	56	64	59	65	62	78
	slave ..	—	5200	3573	7081	4230	8390	11081	9844	7363	9987	10256	—
	master ..	—	3841	1943	7489	5562	8663	9418	9691	9346	9937	9563	12793
March	waters ..	17	29	30	44	49	46	56	61	57	57	58	76
	slave ..	884	2737	3568	2814	3115	7072	8774	7027	4781	4916	4282	—
	master ..	291	1268	1454	4413	2738	4964	5218	5608	3068	5545	5562	8382

Table A2 (continued):

(e) **Wigeon**

		1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
October	waters ..	29	29	31	41	38	47	47	53	49	53	59	78
	slave ..	7548	11197	5794	20937	15579	11894	18383	15646	11565	18734	13109	—
	master ..	8558	9710	7066	14931	15290	16152	16588	17165	16078	16308	19497	22416
November	waters ..	17	24	31	—	36	48	49	59	52	58	59	81
	slave ..	14164	18807	19247	—	26882	22087	35936	36102	36544	34119	23772	—
	master ..	13065	15844	16772	—	28978	31880	25007	27314	35779	29598	31223	44897
December	waters ..	—	30	36	46	41	46	59	55	55	61	57	81
	slave ..	—	17700	13221	25776	31756	37429	31815	36355	40611	41442	28329	—
	master ..	—	19222	21589	40970	44019	46406	39183	45214	44906	45398	53826	66210

		1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
January	waters ..	27	36	24	41	49	55	55	60	55	62	68	85
	slave ..	8828	11749	8802	18668	33213	39985	45139	47096	25860	45262	26954	—
	master ..	7554	14988	10630	28836	30582	34614	34812	38754	35092	37393	35960	46426
February	waters ..	—	29	21	50	47	50	49	55	52	64	62	80
	slave ..	—	8974	7766	19931	28345	48427	39535	62453	29432	42919	29853	—
	master ..	—	6993	5093	28420	22998	31270	17458	33914	32298	37263	30864	41453
March	waters ..	19	30	25	46	51	46	54	60	55	58	64	82
	slave ..	3142	3839	4392	5072	7408	24896	28901	37577	5124	26202	8755	—
	master ..	1976	4680	4687	7006	8222	20216	23247	24934	12424	23983	14544	29224

Table A3: Samples used in calculating seasonal indices from numbers in September-March.

(a) **Tufted Duck**

Season	Number of comparisons	Number in 1959-60	Number in previous season	Seasonal index
1948-49	99	11,397	6,575	58
1949-50	203	23,626	12,105	51
1950-51	172	20,045	13,340	67
1951-52	187	20,018	12,721	64
1952-53	222	25,354	18,160	72
1953-54	242	26,516	17,364	65
1954-55	263	29,984	24,107	80
1955-56	286	31,705	27,557	87
1956-57	291	30,544	27,730	91
1957-58 ..	329	31,029	32,335	104
1958-59	310	29,605	25,930	88

(b) **Pochard**

1948-49	56	7,374	5,302	72
1949-50	118	15,865	9,054	57
1950-51	116	14,885	11,039	74
1951-52	123	14,330	9,230	64
1952-53	171	18,329	19,734	108
1953-54	173	19,629	12,818	65
1954-55	186	13,849	13,808	100
1955-56	213	23,932	22,218	93
1956-57	209	23,630	22,295	94
1957-58	218	24,306	21,976	90
1958-59	208	24,347	23,554	97

(c) **Mallard**

1948-49	137	36,973	24,795	67
1949-50	295	97,120	67,127	69
1950-51	296	100,175	78,900	79
1951-52	349	116,934	84,771	72
1952-53	425	139,657	114,146	82
1953-54	438	157,120	114,174	73
1954-55	494	173,872	135,828	78
1955-56	526	193,373	156,304	81
1956-57	505	174,366	132,789	76
1957-58	556	202,722	171,293	84
1958-59	536	189,150	144,015	76

(d) **Teal**

1948-49	80	14,015	7,063	50
1949-50	199	64,594	26,271	41
1950-51	169	50,097	30,711	61
1951-52	290	83,468	36,086	43
1952-53	322	86,407	41,025	47
1953-54	345	87,205	47,142	54
1954-55	369	100,065	64,694	65
1955-56	407	102,512	77,509	76
1956-57	388	99,249	54,953	55
1957-58	399	101,692	68,484	67
1958-59	401	102,084	46,593	46

(e) **Wigeon** (October-March)

Season	Number of comparisons	Number in 1959-60	Number in previous season	Seasonal index
1948-49	92	31,153	33,718	108
1949-50	178	71.437	72,266	101
1950-51	168	65.837	59,222	90
1951-52	224	120,163	90.384	75
1952-53	262	150,089	143,183	95
1953-54	292	180.538	184.718	102
1954-55	313	156.295	199,709	128
1955-56	342	187,295	235.229	126
1956-57	318	181.577	149.136	82
1957-58	356	189.943	208.678	110
1958-59	369	185.914	130,772	70