WHITE-FRONTED GOOSE STATISTICS, 1952–53
By Hugh Boyd

THE collection of data on the composition of the Whitefront population by the methods described in the Fifth Annual Report (pp. 14–19) was continued and extended in 1952–53. New sources of information included the identification of geese ringed in earlier years and counts of the numbers of single adults. The principal results are : (1) the mean proportion of first-winter birds in 1952–53 was 33 %, a figure similar to those obtained in the two preceding winters ; (2) the mean brood-size was 3·18, less than in 1951–52 but greater than that in 1950–51 ; (3) 6·0% of families were accompanied by only one parent ; (4) only 2·2% of first-winter birds were not in family parties ; (5) estimates of the survival factor from observations of ringed geese suggest that about forty of every hundred geese alive at 1 January die before the following 1 January ; (6) analysis of the composition of the adult population indicates that the proportion of second- and third-winter birds is increasing, or the proportion of older birds decreasing, a condition characteristic of a growing population ; (7) it is shown that many second-winter birds were paired, although no birds less than 3 years old are known to have been parents.

Proportion of First-winter Birds

Table I summarises the counts made in earlier years and during 1952–53. The latter are grouped in seven periods, corresponding to the major changes in the number of geese present. Though it would be preferable to make counts immediately after such changes have occurred, instead of over a period of weeks, this is not often practicable.

TABLE I
PROPORTIONS OF ADULT AND FIRST-WINTER GEESE IN WINTERING FLOCKS

Season	Period	Sample			Proportions	
		Adult	1st Winter	Total	Adult	1st Winter
					Per cent.	Per cent.
1947–48		481	125	606	79	21
1948–49		532	141	673	79	21
1949–50		1957	536	2493	78	22
1950–51		1309	718	2027	64	36
1951–52		3001	1752	4753	63	37
	October	482	165	647	74	26
	November	622	378	1000	62	38
	Early December	1186	814	2000	59	41
1952–53	Early January	1998	1002	3000	67	33
	Late January	1275	525	1800	71	29
	Late February	1511	589	2100	75	25
	Early March	887	413	1300	68	32
1952–53	Whole season	7961	3886	11,847	67	33

The changes in the proportion of young birds after each large influx or departure are statistically significant in all cases except that of the increase in early December. These changes contrast interestingly with the observations of 1948–52, when the proportion of young birds remained sensibly constant from mid-November to the end of January, or even later, in each season (see Table II, p. 15, *Fifth Annual Report*). But analysis of the causes of fluctuation is not yet possible, since no reliable methods of distinguishing newcomers from established birds have been found. Small groups of new arrivals sometimes attract attention by resting apart from the main flocks, or by remaining for some time on the mud-banks in the river, but the identity of such groups is very soon lost and many others seem in no way distinguishable.
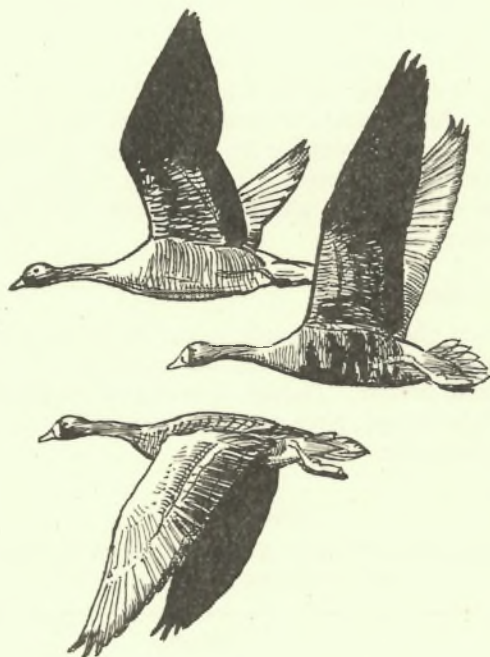
Brood-size

From Table II it will be seen that in 1952–53 the distribution of brood-sizes was similar to that found in 1949–50 and 1950–51, though with a mode of two, instead of three. This increases the likelihood that the distribution found in 1951–52 was exceptional, without enabling the difference to be explained.

TABLE II

BROOD-SIZE IN WINTERING WHITE-FRONTED GEESE

Season	No. of Broods	Size of Brood									Mean Brood-size
		1	2	3	4	5	6	7	8	9	
1949–50	145	12	34	44	26	23	5	1	—	—	3.25
1950–51	319	34	91	106	53	22	8	5	1	—	2.94
1951–52	150	21	27	23	27	27	18	4	3	—	3.64
1952–53	408	52	108	89	79	44	28	6	—	2	3.18

Anomalous Families

Most sexually mature adults and nearly all juvenile (first-winter) geese live in family parties which, unless artificially disrupted, remain united throughout the winter. A normal family comprises two adults with up to seven juveniles (seven being the largest clutch recorded), but families of abnormal composition are seen quite frequently.

In 1952–53 26 families in 408 (6·0%) were recorded as having only one adult. In a few cases this may have been due to the temporary absence of the second parent, but in most it must have resulted from genuine loss. The proportion of single-parent families (4 in 168, 2·4%) was significantly lower amongst the earliest arrivals than in the main winter flocks. This suggests that the loss of parents is due largely to winter mortality, of which shooting is apparently the most important cause.

Some families are accompanied by more than two adults. Usually there is only one additional member, but in a very few instances two have been recorded and on one occasion three. It is not easy to obtain satisfactory records of instances of this kind, because prolonged observations are needed to determine the extent of the association. In December 1947 Lebret (*Ardea* 36 : 198–200 1948) and Scott recorded one four-adult and eight three-adult families in a sample of twenty, but this proportion seems quite exceptionally high. In 1952–53 not more than 1·5% of families were accompanied by three adults and no four-adult families were seen. Three-adult families may have originated in several ways. Some cases of bigamy have been found, though there is no means of determining whether the association existed in the breeding-season or only developed subsequently. In other families the adherence of a third adult seems to be less permanent, perhaps only a matter of days. Watching of ringed birds has shown that the additional adults may sometimes be second-winter birds, very probably the offspring of the previous year. Lorenz (personal communication) has found that in flocks of Greylag Geese kept in semi-captivity immature birds may be re-admitted to the family after the breeding-season following that of their birth.

Families in which the parents are accompanied by more than seven juveniles are also seen (0·3% of families in 1950–51, 2·0% in 1951–52, 0·7% in 1952–53). Broods of eight and nine might represent true families, even though clutches of this size have not been reported. But a brood of ten seen in 1951–52 and one of twelve in 1952–53 are most unlikely to have originated in this way and it is probable that these exceptionally large broods are due to the successful admission of goslings which have lost their parents. Similarly large broods have been seen among Pink-footed Geese in autumn and Scott (*Fifth Annual Report*, 1953) has described how reshuffling of families can occur after mixing as the result of disturbance when the goslings are still small.

From observations on the White-fronted Geese it seems that acceptance of juveniles into families during the winter must be unusual. It is thus remarkable that only 29 juveniles in 1328 (2·2%) were recorded as unattached in 1952–53. The proportion in 1950–51 was closely similar and in 1951–52 probably even less. This indicates how effective the mechanisms preserving family coherence must be, since scattering of families after disturbance, especially by shooting and during fog, may be readily observed. Most of the unattached juveniles seen were single, but a few were grouped in ' broods.'

The Survival of Ringed Geese

Observations on geese marked in earlier years provide information on survival and on changes in the status of individual geese. For both purposes it is necessary that the marked birds should be individually identifiable, or at least assignable to age- or year-classes. White-fronted Geese are exceptionally suitable for studies of this kind, since the individual variations in the belly-markings of adults often make recognition possible even when ring numbers cannot be read, but comparatively few have been ringed, so that the results so far obtained are indicative rather than definitive.

In estimating mortality rate from the survival of ringed geese the small size of the samples, difficulties in recognising individuals, and lack of information on the extent to which geese visiting the New Grounds in one season or at one time of year return in later years or at different times in the same season are some of the major sources of potential error. But, assuming that the behaviour of ringed birds is typical of the wintering population, that most of the geese visiting the New Grounds in one season and surviving till the next will reappear there, and that most of the marked birds will be recognised, it is possible to estimate the survival factor from the numbers of geese seen in seasons after that in which they were marked. The geese have been caught in February, and observations made between October and March, but mortality at the New Grounds is small compared with that sustained elsewhere so that for a first approximation all data can be referred to mid-winter. Let P be the constant survival factor, so that out of a total number of individuals N_t alive at time t, PN_t are alive at time $t+1$. The unit of time is a year, from 1 January to 1 January. It can be assumed that, for White-fronted Geese which are more than six months old, the death-rate is approximately the same for all age classes in the population.

Sixty-nine geese were ringed in February 1950. At least 23 of these were seen in 1951–52 (two years after ringing) and at least 20 in 1952–53 (three years after ringing). From the 1951–52 observations, the mean value of P for the years 1950 and 1951 is 0·57. From the 1952–53 observations, the mean value of P for the years 1950, 1951 and 1952 is 0·66. In addition, at least 23 of the 48 geese marked in February 1952 were seen in the following winter, giving P (1952) $=0·48$. The mean of these values is P $=0·57$, i.e. of 100 geese alive at 1 January only 57 survive until the following 1 January. These estimates are very probably somewhat too low, because it is unlikely that *all* the ringed geese returning to the area were identified.

If the population can be assumed stable, with production just replacing losses, the ratio $\frac{\text{adults}}{\text{total geese}}$ found each season (Table II) provides an estimate of P. The populations described in Table II are, however, theoretical ones, when relationship to the geese actually visiting the area is uncertain, and the assumption of stability is likely to be fulfilled only imprecisely, but the indicated values of P in 1950–53 (0·63–0·67) are not far removed from the estimates based on sight records of ringed geese.

Composition of the Adult Population

Two analyses of the (theoretical) adult populations in the last four winters are summarised in Table III. In the first part of the table the proportion of parents is calculated from the mean brood-size on the assumption that all broods have two parents. The error introduced by the fact that some broods have only one parent is negligibly small.

The second part of the table shows the proportions of the population expected to belong to different age classes. This analysis replaces that used in an earlier account (Table IV, p. 17, *Fifth Annual Report*), in which a classification into 'sexually immature' and 'mature' adults was made. The latter involved the assumption that all second- and third-winter birds are sexually immature, which may not be correct. For the season 1950–51 two calculations were made, the first assuming a constant survival factor, the second assuming a change in the survival factor corresponding to the alteration in the $\dfrac{\text{adult}}{\text{total population}}$ ratio between the winters of 1949–50 and 1950–51. The modification produces no considerable difference. There is an apparent increase in the proportion of young birds in the population during the last two years. This may prove to be only temporary, the result of 'good' breeding-seasons or a recovery from the effects of the 'bad' season of 1949. But if sustained it would indicate a change in structure corresponding to a change from a stable population to a growing one.

TABLE III

THEORETICAL COMPOSITION OF ADULT POPULATION

Season	Parents	Adults Without Families	Age Classes			Survival Factor P
			2nd Winter	3rd Winter	4th Winter and older	
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
1949–50	17	83	21	17	62	Constant
1950–51	38	62	22	16	62	Constant
			22	17	61	0.79 and 0.65
1951–52	32	68	36	14	50	Constant
1952–53	31	69	37	23	40	Constant

When do White-fronted Geese Pair ?

From the point of view of population dynamics it is of considerable importance to know when geese form pairs and at what age they first breed. Heinroth (*Die Vogel Mitteleuropas*, **3**, 1926) and Lorenz (personal communication) report that Greylag Geese may form pairs at a year old and breed at two years. This has also proved to be the case with the Hawaiian Geese at Slimbridge. Kossack (*American Midland Naturalist* **43** : 627–649, 1950) found that at least a fifth of the two-year-old members of a semi-captive flock of Canada Geese nested and Hanson and Smith (*Bull. Illinois Nat. Hist. Survey*, **25** : 67–210, 1950) assumed tentatively that all Canada Geese in the wild breed at two years old, although direct evidence on the point was lacking. But it is somewhat risky to assume that the behaviour of semi-captive flocks is representative of that of wild birds and dangerous to apply findings from studies of one species to another, so that it is desirable to verify the facts for wild White-fronted Geese directly, if this is at all possible.

The study of pair formation is primarily a behavioural one, but it can also be approached statistically, by the collection of data on the relative numbers of single and paired adult geese without families, if adequate criteria for the recognition of pairs can be found.

From the work of Heinroth (*loc. cit.*) on Greylags it seems likely that partici-
pation in a 'triumph ceremony' would provide an absolute criterion for the
existence of a permanent bond but this is of no practical value, since such
displays are very infrequent amongst White-fronted Geese in winter. Other
criteria are less absolute, but joint action in attack or defence against other
geese is almost entirely limited to pairs, as opposed to temporary associates, and
the closeness and attentiveness with which members of a pair follow each other
will usually indicate the relationship. If a group of twenty to thirty geese is
watched for half an hour there is usually little doubt of the affinities of its
members. But the collection of data in this way requires much time and during
1952–53 attempts were made to determine the proportion of single adults by
comparatively rapid scanning of flocks of several hundred geese. It was found
possible to describe at least 90% of adults without families as 'single' or
'paired,' provided that flock density and activity were not too high and the
geese were sufficiently close to the observer. Moreover, comparison of results
obtained by 'scanning' with those from continued watching of small groups
revealed satisfactory agreement between the methods at several times during the
winter. Numbers counted in four periods are shown in Table IV, together with
the only sufficiently large sample from earlier years, that of December 1950.

TABLE IV
PROPORTION OF SINGLE ADULT GEESE

Period	Single Adults	Paired Without Families	Single $\frac{\text{Single} + \text{Paired}}{}$ Per cent.	Single Adults $\frac{\text{All Adults}}{}$ Per cent.
December 1950	72	194	27	17
October 1952	240	584	29	20
Early December 1952 ..	196	664	23	16
Early January 1953 ..	176	466	27	19
Late January 1953 ..	115	382	23	16
1952–53	727	2096	25	17

The feeding habits of the geese prevented the collection of data in February and
March 1953. The proportion of single adults is seen to vary considerably, but
this variation is not simply related to the period of observation. The fluctuations
may be due to the arrivals and departure of more or less unified groups, within
the total flock, in which the $\frac{\text{single}}{\text{pair}}$ ratio varies widely.

It appears that in 1952–53 23–29% of adults without families (16–20% of all
adults) were single. Records of the status of ringed birds show that 3 of 29
geese known to be in their third winter or older (and 1 of 20 fourth-winter or
older) were single, i.e. about 10% of these older birds were single. Geese in their
third or subsequent winters constituted some 63% of the adult population.
Thus, single adults in their second winter made up 10–14% of the total adult
population. But it is probable that second-winter birds constituted 37% of the
adult geese (Table II), so that it is likely that quite a high proportion (perhaps
as much as three-fifths) of the second-winter geese were in pairs by the end

of January 1953. The proportion in December 1950 agrees very closely.

Conclusive proof that pairing takes place during the winter has yet to be provided. Though two second-winter geese were members of three-adult families, this does not indicate that they were parents. Nor can it be shown beyond doubt that any third-winter geese were parents. Table III indicates that it is quite possible for all the successful parents to have been older birds (in their fourth or subsequent winters).

SHORT NOTES ON GEESE

NOTES ON THE BELLY-MARKINGS OF WHITE-FRONTED GEESE

The occurrence of more or less extensive patches of black or blackish-brown feathers on the abdomens of adult White-fronted Geese (*A. albifrons*) and Lesser White-fronted Geese (*A. erythropus*) is one of the most obvious aids to identification of these species. Similar patches are found also in the Greylag Goose (*A. anser*), but are typically much less extensive than in *albifrons* and *erythropus*. From casual observation it is clear that the extent of these patches varies widely between different individuals and more critical examination of skins has shown that birds of the Greenland race (*A. a. flavirostris*) tend to have heavier markings than do other forms of *albifrons* (Dalgety and Scott, *Bull. B.O.C.* **68**(6) : 109–121 1948). Tucker (in Witherby *et al., The Handbook of British Birds*, **3** : 1939) writes that the variability of these markings ' is not directly dependent on age or sex,' but Alpheraky (*The Geese of Europe and Asia*, 1905), although not claiming any correlation between marking and sex, has asserted with some force that in the Greylag and both species of Whitefront the black markings increase in number and size with the age of the bird, being few and small in two-year-olds and continuing to extend in fully adult birds until they ' may at last occupy almost the whole belly.' Since the vehemence of Alpheraky's pronouncements is inversely related to their truth and since his belief conflicts directly with that of Tucker it seemed desirable to re-examine the problem. Presumably both writers' opinions were based on the study of museum skins. Though it is possible when determining the sex of a goose by dissection to discover whether the bird has attained sexual maturity, no criteria are known