Weights and measurements of Greylag Geese in Scotland

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Introduction

Our text is a quotation from Giles (1963), 'one of the most-taken but least used observations by wildlife investigators is total body-weight. The field-notes of hundreds of workers are filled with thousands of weight observations of animals but rarely are these presented in reports or used in research conclusions'.

Taxonomists have generally disregarded body-weight as being too widely variable within the population to serve to separate racial groupings. Their requirements are met by linear measurements, those of the wing and, particularly in the case of geese, of the bill. Pathologists also tend to be wary of total weight as a sole indicator of the state of health, although the medical propaganda against over-weight in humans might lead us to think otherwise. It is the rise of interest in bioenergetics, the study of the flow of energy in biological systems, that has refocused attention on animal weights. For a full study, the weights of the different organs and the proportions of fatty and other tissues must be determined. The gross body-weight is thus only a starting point, but one needed for many practical studies as well as academic ones. It, and its variations, must be known if we are to give good answers to such questions as how much will a flock of geese eat; what will be the effect on an aircraft of collision with a goose in flight.

Beer and Boyd (1962, 1963) published extensive data on the Pink-footed Goose *Anser brachyrhynchus* and European White-fronted Goose *Anser albifrons albifrons* in Britain. In the case of the Western Greylag *Anser anser anser*, Elder (1955) published the weights of 259 geese rocket-netted during ten days in November 1953. These gave weights which were surprisingly low when compared with records extant in the British shooting literature. While recognising that his sample was taken early in the season and contained a large proportion of young birds, Elder was inclined to believe that his results indicated the existence of lighter sub-races. The need for further weight samples taken at other times during the winter was clear.

Material and methods

The Wildfowl Trust's rocket-netting programme had concentrated on the Pink-footed Goose since this proved the easiest to trap in the large numbers needed for the capture/recapture method of population estimation. Greylag fly in smaller flocks and do not land so thickly. The flock size, moreover, becomes smaller as the season progresses. Accordingly, when sufficient recoveries of ringed birds had been accumulated to indicate clearly the migratory patterns and mortality estimates from the British-wintering population, the expensive activity of rocket-netting this species ceased. Only about a hundred more weights from this source are thus available to add to Elder's series. However, with the establishment of a National Nature Reserve at Loch Leven, Kinross, and of a Wildfowl Trust research team there, we had access to the bags of the shooting parties, through the courtesy of the landowner. Commercial shooting in Britain came to an end in 1968 by legislation in which the Wildfowl Trust had not been unconcerned. Advantage was therefore taken of the last two seasons before the new law became effective to examine the birds stored temporarily in the cold room of one of the largest game-dealers in Perth. Finally, a small number of unpublished weights from Greylag adults rounded up while flightless in Galloway (Boyd 1966) were added.

The total sample available is set out in Table I. Besides weights (to the nearest 10 gm.), measurements of wing-length (the cord of the closed wing without flattening of the primaries) and bill-length (exposed culmen) were taken (to the nearest mm.). Not all the birds had all measurements taken, the actual sample sizes being as indicated in the appropriate sections. Sex was determined by cloacal eversion, age by the presence or absence of notched tail-feathers in the autumn and of other juvenile feathers (particularly the wing coverts) later in the season. Besides listing the minimum and maximum measurements encountered, the calculated means are given together with two statistics based on the dispersion (standard deviation) of weights about the mean. The standard error of the mean (s.e.) is derived from (standard deviation)/(square root) of the number of observations. By taking sample size into account as well as dispersion, it enables us to determine whether differences in means are large enough to be statistically significant (at the 5% level). The coefficient of variation (V),

being (standard deviation × 100)/(mean), takes unit size into account and so enables comparison of dispersion between samples of dissimilar weights or indeed of dissimilar units, for example weights and wing-lengths.

Variation in weight by age, sex and season

The full data are set out in Table II. In common with earlier studies, these show that males are consistently heavier than females and that this distinction holds in However, there is a considerable overlap in both cases and weight alone is not diagnostic of sex — nor, indeed, of age, young males frequently being heavier than adult females.
first winter birds as well as in adults.

Of more interest is the clear demonstration of seasonal variation in weights. All sexes and ages are at their lowest weights in October, when they have just arrived on migration from Iceland. They then increase to a maximum weight in December, feeding on the ample supplies of harvest-wasted grain and potatoes, supplemented by grass. In January, when the principal food is exhausted and the birds turn predominantly to grass (not then at its most nutritious) plus some winter wheat, the weights in all classes fall back

Table I. The total sample of Greylag measurements available and the means by which it was obtained.

Source	*Locality*	*Years*	*Ad.* ♂	*Ad.* ♀	*Juv.* ♂	*Juv.* ♀	*All*
Rocket-netting	Solway Kinross	1953, 1959	121	121	61	52	355
Shooting bags	Kinross	1966-69	67	70	54	46	238
Game-dealers	Perth	1966-68	138	89	109	94	430
Moulting	Galloway	1964-66	36	30	—	—	66
			362	310	224	193	1089

Table II. Weights (in gm.) of Greylag Geese.

	No.	*Minimum*	*Mean*	*Maximum*	*s.e.*	*V*
Adult males						
Oct.	42	3030	3454	3790	38	7.12
Nov.	110	2890	3480	4400	29	8.78
Dec.	52	2740	3793	4250	48	9.04
Jan.	94	2600	3509	4560	31	9.78
Feb./Mar.	13	2850	3469	4040	32	11.53
June	36	3200	3692	4300	41	6.74
Adult females						
Oct.	45	2540	3039	3470	29	6.49
Nov.	105	2080	3101	3770	27	8.98
Dec.	25	2070	3170	3960	74	11.64
Jan.	75	2160	3108	3800	32	8.79
Feb./Mar.	7	2900	3323	3500	131	10.44
June	30	3000	3237	3600	33	5.33
First winter males						
Oct.	9	2730	2900	3170	60	6.19
Nov.	63	2580	3075	3690	32	8.32
Dec.	21	2540	3297	4250	58	8.12
Jan.	82	2160	3083	4160	37	10.97
Feb./Mar.	1	—	3420	—	—	—
First winter females						
Oct.	8	2430	2722	2990	64	6.61
Nov.	60	2120	2866	3440	31	8.42
Dec.	22	2810	3174	3540	44	6.57
Jan.	52	1980	2726	3220	40	10.55
Feb./Mar.	8	2460	2772	3120	91	9.26

to the November or even October level. February is one of the hardest months in Scotland, with frequent snow-cover and March often shows little improvement. However, as the shooting season ends on 31st January, only a few weights are thereafter available from birds shot, under licence, for other research purposes. No definite conclusion can therefore be drawn, but it looks as if there is, overall, little change from the January weights. It would be of great interest to get more weights at this end of the season, and especially in April when a re-building of reserves may occur prior to the long migration. As we indicated earlier, a full-scale rocket-netting attempt is unlikely to be economical at that season. Possibly smaller cannon-nets might, in some circumstances, produce a sufficient sample for our purposes.

The seasonal variation in the various classes may be more easily compared if the peak in each is taken as 100 and the other mean weights expressed as percentages (Table III). As would be expected, the first winter birds show slightly steeper rises to their peak. They are still growing as well as, presumably, replacing reserves used on migration. The fall in their weights in January is also marked (the November - December - January rise and fall are statistically significant on the original data). This is in contrast with the findings of Raveling (1968) on Canada Geese *Branta canadensis interior*. His young birds showed no changes in weights through the winter, whereas the adults did show a late-winter drop. Raveling could not satisfactorily account for this surprising difference, which suggests that adults were at a disadvantage in obtaining food supplies. One possibility he did not consider was that the lighter young birds might be eliminated early from the population, through competition, thus keeping up the mean weight which would otherwise have fallen. In our case no such involved explanation is necessary, a definite drop in young birds' weights did occur. However, there is a much greater dispersion about the means (as measured by V in Table II) in January, suggesting that selection for food-gathering ability is making itself felt when supplies are low.

A very similar, and significant, rise and fall in mean weights also occurred in the adult males. The trace of such a peak is apparent in the adult female figures, but is not statistically significant. On the present evidence it would thus seem that the adult females are better at exploiting such food sources as are available. This clearly would be advantageous to the species. The adult females may also actually regain their weights quicker in the early spring, but the few suggestive figures available are insufficient for proof. We do not, unfortunately, have any weights for Greylags in Iceland to show what weights are achieved just before breeding. The small number of weights collected after the breeding season, in June in Galloway, are, rather surprisingly, similar to the December high, the mean for males being 98% and that for females 102% of that peak. Some caution must be exercised here for, although the Galloway birds are of Icelandic/British stock, they are feral in origin and non-migratory in habit. They might therefore have become somewhat larger. This point is taken up again when we consider linear measurements. The other point is that these birds were captured when flightless in the moult. If captured early in this stage, they might be expected to have plenty of reserves, if late these would have been largely exhausted. These variations have been studied for the Canada Goose by Hanson (1965).

Table III. Seasonal variation in mean weights of Greylag Geese expressed as a percentage of the peak.

	Oct.	*Nov.*	*Dec.*	*Jan.*	*Feb./Mar.*
Adult males	91	92	100	92	91
Adult females	95	98	100	98	(105)
First winter males	(88)	93	100	93	(104)
First winter females	(86)	90	100	86	(87)

Variation in weights between samples

It is axiomatic that samples of geese obtained by shooting will be unbalanced as regards ages, the young birds being much more likely to be shot. It is less generally accepted that one sex is more likely to be shot than the other. Certainly the male:female ratio is near to unity in the long series of geese, Pink-footed as well as Greylag, which the Wildfowl Trust has caught by rocket-netting without baiting. This is exactly so in the sample used in the present discussions

(Table I). It was therefore surprising to find that the adult shot birds collected at the Perth game-dealers should have such a high proportion (61%) of males, whereas the adults shot at Loch Leven were, again, near unity as regards the sex ratio (49% males). However, Imber (1968) has now found that adult male Canada Geese in New Zealand have a significantly higher hunting mortality than females and he demonstrates that studies in North America indicate a similar conclusion. Differences in conditions may affect the sex ratio in geese caught by baited cannon-nets. Thus Nass (1964) normally had a 50:50 sex ratio in catches of Canada Geese. But catches made when natural food was very short resulted in 1,039 adults being caught, of which 62% were males. Similarly, different shooting techniques may explain the difference between the present two samples of Greylags. The Loch Leven birds were mainly shot for sport as they returned to the roost. The Perth birds, being shot for commercial gain, might well have been obtained by less scrupulous methods. Very heavy kills can be made by shooting over decoys in certain weather conditions. It is quite possible that adult males decoy more readily than females. This is a fascinating subject, with implications for the population stability of a species which is essentially monogamous. However, we cannot pursue it here, the main object of the discussion being to show that unbalanced sex ratios in a sample *could* occur without selection for the market.

This latter possibility had worried us, because it might imply that the shooters were selecting the heaviest birds for sale, resulting in a preponderance of big males. Our conclusions on mean weights for the population would then be biased. To check the point further, the two shot samples were compared for the period of the main shooting season, November to January (Table IV). Although the Perth birds were slightly heavier in many of the categories, none of the differences between means have statistical significance. Moreover, if there were selection against small birds, it should fall most on the smallest category, the first winter females. Instead we find their Perth sample had a mean weight identical with that of their Leven sample and showed more variation (V) instead of less (which it would have done if one end of its range had been removed). We may anticipate here the finding of the wing measurements which also indicate no difference in size between geese in the two samples. We also ascertained that the dealer purchased geese by the bird, not by weight.

We therefore conclude that it was proper to incorporate the Perth game-dealer's sample and yet have a representative sample of weight ranges in the various age and sex categories. By the same evidence in Table IV we can reject the possible criticism that the geese held in cold-store at Perth would be lighter than normal because of water loss. We ascertained that geese were normally held for only a few days (our measurements were accumulated over a series of visits) and, in any case, water loss would be slow in a bird of this size.

It is much more difficult to make any meaningful comparison between the weights of Greylag in our present shooting samples and those in published game-bag records. These do not specify age and sex nor, of course, dispersion within the categories. Those which at least specify sample size and mean weight are Beveridge (1918) — 300 birds, mean 3,370

Table IV. Weights (in gm.) of Greylag Geese, shot November to January, from two sources.

	No.	*Minimum*	*Mean*	*Maximum*	*s.e.*	*V*
Adult males						
Leven	50	2540	3586	4100	55	10.87
Perth	125	2600	3639	4560	31	9.65
Adult females						
Leven	60	2070	3087	3740	45	11.43
Perth	65	2080	3166	3960	37	9.52
First winter males						
Leven	32	2250	3062	3650	68	12.50
Perth	81	2160	3163	4250	42	11.86
First winter females						
Leven	26	2120	2865	3440	58	10.41
Perth	63	1980	2864	3540	44	12.12

gm.; and Ogilvie (1920) with 50 birds and Popham (1943) with 83, both with means of 3,400 gm. These are all higher than the overall mean for the Perth sample (3,285 gm., s.e. = 25, V = 13.8, for 334 birds). We may allot standard errors to the older means by first making the assumption that they had the same coefficient of variation as the Perth sample. We then conclude that the difference between their mean weights and that of the Perth sample is not significant for the Ogilvie sample and only just reaches significance for the other two. It is therefore not very profitable to seek to explain the differences when so many variations in sampling may have been concerned. In the bad old days with spring shooting, heavier birds might be expected to have been included. However, it should be noted that Beveridge was concerned with North Uist, and thus with another non-migratory population. Certainly it is most desirable to obtain some data from the Outer Hebrides at the present time.

The weight of the 'average' Greylag

Having laboriously assessed weights in categories of age, sex and season it may appear paradoxical to conclude by lumping them into one 'average' figure. But, as explained in the introduction, such an 'average' is often called for as a 'practical' requirement.

We must obviously confine ourselves to the winter half of the year, October-March. The means for this period in Table II, if lumped regardless of sample size, would give for 311 adult males — 3,531 gm.; for 257 adult females — 3,105 gm.; for 176 first winter males — 3,119 gm.; for 150 first winter females — 2,864 gm.; and for the whole sample of 894 — 3,213 gm. This figure must obviously be adjusted on several counts and we make the following assumptions, that a) sexes are equal in number, b) the mean monthly weights are representative of each category, and c) the proportion of the young is 20%. This latter is a compromise figure. The data on age-ratios accumulated in ten years of November counts from 1958 to 1967 by H. Boyd and M. A. Ogilvie (unpublished) gave a mean figure of 28.9% of first winter birds. However, we also know that these have a much higher mortality rate than adults, because of their vulnerability to shooting. The proportion of young in the population will thus decrease through the winter. The data available do not permit a precise estimation of a mean figure for the winter, but that chosen would appear to be reasonably realistic. It is unfortunate that we were not sufficiently skilled in cloacal probing to be able to separate out yearling (second winter) birds from full adults, as has been done by Hanson (1962) for Canada Geese. It is probable that, as in that species, yearlings are distinctly lighter. Their varying proportion in the population would, therefore, also affect the average adult weight.

Making the specified assumptions, we arrive at the winter weight of the 'average Greylag-in-the-field' as 3,270 gm. (7 lb. 3 oz.).

The weights of sheep vary widely, of course, but we are advised that 60 kg. is likely to be a fair average. This is 18 times the weight of our 'average' Greylag and gives some idea of the relative amounts of food that might be eaten by each animal. However, we must caution against assuming a straight relationship between weight and consumption. Differing efficiencies of digestion and differing calorific requirements are likely to reduce the sheep: goose ratio. Again it is stressed that it is only at certain times that sheep and geese are in direct competition (Kear 1963).

It has been shown experimentally (McNaughton 1968) that damage to aircraft by bird impact is proportional to the mass of the bird and to the cube of the speed. The Air Registration Board requires that windscreens and engines must be safe against birds up to 4 lb. weight collided with at the aircraft's maximum speed. It is thus distinctly hazardous to site airfields near a goose roost.

Variation in wing-lengths

The basic data are set out in Table V. They confirm the size relationships between the various age group categories as determined by the weights. Their main use will be in making comparisons with other races of Greylag. In this connection it should be noted that the coefficient of variation (V) is much smaller than in the case of weights, the measurement is less subject to fluctuation, and is more representative of its particular category.

In view of the disquiet occasioned by the preponderance of adult males in the Perth sample, it is reassuring to find (Table VI) that the Leven males were, if anything, just marginally larger as measured by wing-length. The other categories were almost identical in this respect. This confirms that there had not been selection of large birds for the market at Perth.

Table V. Wing-lengths (mm.) of Greylag Geese.

	No.	*Minimum*	*Mean*	*Maximum*	*s.e.*	*V*
Adult males	191	436	467.4	500	0.83	2.46
Adult females	157	417	447.2	480	1.06	2.98
First winter males	122	418	450.0	482	1.20	2.95
First winter females	119	390	432.6	466	1.38	3.48

The other point that emerged from the study of wing-lengths was that the young birds showed no appreciable growth in this respect over their first winter. If we divide their sample into measurements taken October-December and those taken January-March the means for 69 and 50 females are exactly the same (432.6 mm.). The males show a slight increase from 59 with a mean of 448.4 mm. to 63 with a mean of 451.4 mm. However, with standard errors of 1.62 and 1.76 the difference is not significant.

Variation in bill-lengths

The length and configuration of the bill has been frequently used in attempts to separate races within goose species. The length of exposed culmen was therefore measured in sufficient birds to give a representative sample and the results are set out in Table VII.

Again males and females show a significant separation of their means both in adult and first winter birds, but again there is too much overlap for the sexes to be separable on this count alone. Boyd (1966) sought to quantify the finding of experienced observers that they can distinguish males from females on head size and shape. To this end, for the Galloway sample, he also measured the height and width of the bill at the base and the length and width of the head. It was hoped that a simple discriminant function, using two or three measures would suffice. However, with the measurements made this was not found to be so.

As in the case of wing-length, there was little growth in the bills of young birds during their first winter. Both showed a slight increase between the means of the October-December and January-March samples. In the case of the males the increase was from 58.8 mm. (55 birds, s.e. 0.49) to 60.2 mm. (30 birds, s.e. 0.43) and this is just significant. In the females the increase, from 55.2 mm. (61 birds, s.e. 0.38) to 56.4 mm. (31 birds, s.e. 0.54), just fails to reach significance. In both cases the second figure is virtually identical with that of the adult. Thus the

Table VI. Wing-lengths (mm.) of Greylag Geese, from two samples.

	Adult males		*Adult females*		*First winter males*		*First winter females*	
	No.	*Mean*	*No.*	*Mean*	*No.*	*Mean*	*No.*	*Mean*
Leven	114	470.7	80	446.9	36	451.1	34	433.0
Perth	77	465.2	77	447.5	86	449.4	85	432.4

Table VII. Bill-lengths (mm.) of Greylag Geese.

	No.	*Minimum*	*Mean*	*Maximum*	*s.e.*	*V*
Adult males						
Leven/Perth	125	54	60.0	66	0.24	4.43
Galloway	63	54	63.3	69	0.37	4.69
Adult females						
Leven/Perth	117	47	56.2	62	0.24	4.71
Galloway	51	53	58.6	66	0.40	4.83
First winter males						
Leven/Perth	85	49	59.3	66	0.36	5.53
First winter females						
Leven/Perth	92	44	55.6	64	0.32	5.45

bill is fully grown in the first winter although the body size (as specified by the weight and wing-length) remains well below that of the adult of the same sex. Presumably it is more important, in terms of survival, for the feeding instrument to reach full size quickly. In a way, we have here a quantification of the gawky look of first winter geese.

The values of V indicate that bill-length is much more variable within a population than is wing-length. While less useful for specifying the population, it may be more readily modified in response to ecological changes. In both adult males and females the bill-lengths of the Galloway sample are significantly greater than those of the Leven/Perth sample. We have already seen that the weights of the Galloway birds, caught in wing-moult, were rather surprisingly high. It would be most interesting to sample this semi-resident stock at other times, when the wing can be measured, to see if it is indeed becoming bigger bodied. So too, as we have already seen, would data be welcome for the non-migratory population of Greylag breeding in the Hebrides. Such as are available at present are too few for conclusions to be drawn. The geese there have shown themselves particularly adept at avoiding round-ups, being considerably favoured by the terrain.

Other geese in the samples

One of the surprises of this study was the small sample of Pink-footed Geese available for measurement at Loch Leven (85) and especially at the game-dealer's in Perth (38). This does not reflect the abundance of this species relative to the Greylag. Thus censuses carried out in November gave, for the adjacent counties of Perthshire, Fife and Kinross, totals in 1966 of 35,030 Greylags and 34,060 Pinkfeet, in 1967 of 30,150 Greylags and 26,820 Pinkfeet (Ogilvie 1968) It may well be that Pinkfeet are more difficult to shoot in large numbers and, certainly, experience at Loch Leven would bear this out. In view of our earlier discussion on the possibility that shooting methods might explain the preponderance of males in the adult sample at Perth, it is perhaps worth noting that the adult Pinkfeet there comprised 10 males and 11 females.

Also at the Perth dealer's was a small sample of Barnacle Geese *Branta leucopsis*, 70 birds in all. As this species is protected on the mainland of Scotland, these birds should not have come from the population wintering on the Solway, which ringing has shown to derive almost exclusively from Spitsbergen. The probable source was the Hebridean islands west of 5°W. on which there is a short open season. Their main stronghold is the island of Islay. Ringing has shown that this Hebridean population derives exclusively from breeding grounds in Greenland. Boyd (1963) has recorded the weights of 35 adults captured on the Solway, together with those of 13 rounded up flightless in Spitsbergen. Detailed analysis and publication of the present limited data was not considered to be justified and it remains on file at the Wildfowl Trust, together with unpublished weight data on 596 birds rounded up flightless in Greenland on three expeditions.

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Summary

1. Mensuration data for Western Greylag Geese *Anser anser anser* from various sources in Scotland are analysed.
2. The mean weights of males and females, and of first year and adult birds are significantly different but there is considerable overlap. There are variations in mean weight through the season, a peak being reached for all classes in December.
3. An imbalance in sexes on one of the samples is discussed and is thought likely to reflect different shooting techniques.
4. The weight of an 'average' Greylag is calculated to be 3,270 gm. (7 lb. 3 oz.).
5. Wing- and bill-lengths again are characters that separate but are not diagnostic of the sexes. Young birds have wings shorter than adults but their bills have reached full size in the first winter. In neither respect does much growth occur while on the wintering grounds.
6. On both weight and bill-length data the non-migratory feral Galloway population would appear slightly larger than the migratory Icelandic one.

7. Many fewer Pinkfeet occurred in the samples obtained by shooting than would be expected from their numbers relative to those of Greylag, suggesting a differing vulnerability.

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