Biometrics of wild Red-breasted Geese *Branta ruficollis*

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Abstract

Biometrics were taken from 242 Red-breasted Geese *Branta ruficollis* caught in summer on the Taimyr, Yamal and Gydan Peninsulas, arctic Russia in 1996 and 2007–2014, and from 94 birds during four catches on the wintering grounds in Bulgaria in 2011–2014. These biometrics represent the first published data of body measurements, flat wing lengths and mass for Red-breasted Geese using sample sizes of more than 14 birds. Males were larger than females amongst adults and first-winter birds. Adult male body mass was lower in winter than during moult, whereas females showed no significant difference. In common with some other arctic-moulting goose species, the mass of most adult geese remained constant throughout the flightless moult period; however, the mass of non-breeding adult females declined. An index of adult winter flat wing length x body mass was a 100% accurate predictor of sex determined by cloacal eversion (n = 22), but was less successful in determining the sex of first-winter birds (92–93%, n = 27).

Key words: *Branta ruficollis*, flat wing, moulting, moult mass dynamics, sexual dimorphism, total head and bill length.

There have been relatively few details published to date on the biometrics of the Red-breasted Goose *Branta ruficollis*. Mass and measurements from a small sample are given in Alpheraky (1905), from five wild birds in Witherby *et al.* (1939), from nine skins in

Bauer & Glutz (1968) and from samples of fewer than 14 birds in Zyryanov & Sokolova (1979) and Zyryanov & Lisenko (1986). In some cases, the published biometrics did not differentiate between the sexes, nor between adults and first-winter birds. As far as the authors could determine, no other published biometrics were available for the species. This is hardly surprising, as there have been relatively few Red-breasted Geese caught for ringing. Red-breasted Geese are protected throughout their range and measurements of shot birds, killed accidentally or even deliberately, are therefore currently unlikely to be taken or recorded.

Red-breasted Geese were caught during a study of their breeding biology on the breeding grounds in Russia during the 1990s (Kokorev & Quinn 1999; Quinn 2000) and since 2007 (Rozenfeld *et al.* 2012, 2013, 2014), and more recently as part of a LIFE project in Bulgaria during the 2010s (LIFE09/NAT/BG/000230 of the LIFE financial instrument of the European Community) as part of a conservation programme on the species and its wintering habitat. Here we aim to provide more extensive biometrics records, to investigate evidence for sexual dimorphism (recorded in related species) and to describe any seasonal variation in body mass, in particular whether adults lose mass during the annual wing moult or are able to obtain sufficient energy from their diet to meet the needs of feather replacement.

Methods

Red-breasted Geese were caught in northern Russia at several locations on the Taimyr Peninsula (*c.* 72.3°N, 85.9°E) in summer 1996, 2007, 2010 and 2013, on the Yamal Peninsula (*c.* 71.1°N, 70.0°E) in 2014 and on the Gydan Peninsula (*c.* 70.0°N, 78.6°E) in 2012 (Table 1). Both adults and goslings were rounded up during the flightless period using boats and driven into netted pens. Adult males and females were also caught during breeding (on the nest or with small goslings) prior to the annual wing moult. During catches of flightless birds, adult females were checked for the presence of a brood patch, which indicated if the female had laid eggs in that year and had incubated them (Hanson 1959). Adult females with brood patches caught in catches with goslings were considered successful breeders; those with brood patches in catches with no goslings were considered failed breeders; those with no brood patches were considered non-breeders. Geese were also caught using cannon-nets in northeast Bulgaria (*c.* 43.7°N, 28.5°E) in winters 2010/11, 2012/13 and 2013/14. The sex of the geese was determined by eversion of the cloaca (Owen 1980); age (adult or first-winter) on the winter quarters was determined through plumage characteristics (Cramp & Simmons 1977). Measurements of total head and bill length and of tarsus length were measured using callipers accurate to 0.1 mm following Dzubin & Cooch (1992). Mass was determined using a spring balance accurate to ± 10 g. During the annual wing moult, the total length of the ninth primary (usually the longest emerging feather) on one wing was measured using a plastic rule accurate to 1 mm. Using a similar rule, flat wing length (Dzubin & Cooch 1992) of one wing was measured on birds caught in the summer

prior to wing moult and during the winter. Variables were tested for a normal distribution using the Shapiro-Wilk test prior to further statistical analysis and parametric or non-parametric analyses chosen accordingly. Independent-sample t-tests were used to compare flat wing length, head and bill length, tarsus length and mass for the age and sex classes. Linear regression analysis determined the relationship between mass and the total length of the ninth primary. All statistical tests were performed using the statistical environment R (R Development Core Team 2015). Mean values ± standard error (s.e.) are reported.

Results

In Russia, 254 Red-breasted Geese (203 adults and 51 goslings) were caught in June, July or early August, during six summer seasons between 1996 and 2014 (Table 1). Eleven goslings were not sexed and biometrics data from these birds were not used in the analyses. In Bulgaria, 158 Red-breasted Geese were caught in January or February in three winters between 2010/11 and 2013/14 (Table 1). Not all biometrics were recorded for every bird in every catch (Table 1), but at least one size and/or mass measurement was taken from 242 birds in Russia (203 adults and 39 goslings) and 94 birds in Bulgaria (57 adults and 37 first-winter birds).

The mean flat wing length of adult males was found to be significantly longer than that of adult females ($t_{43} = 6.25$, $P < 0.001$) and those of first-winter males were significantly longer than for first-winter females ($t_{25} = 4.81$, $P < 0.001$, Table 2). The mean flat wing length of adult males was also significantly longer than that of first-winter males ($t_{35} = 5.24$, $P < 0.001$) and those of adult females were significantly longer than for first-winter females ($t_{33} = 2.82$, $P < 0.01$).

Too few head and bill and tarsus measurements were taken in Bulgaria to make any comparisons with those taken in Russia. However, from the measurements taken in Russia, both the head and bill, and also tarsus length, were significantly longer in adult males than adult females ($t_{149} = 12.40$, $P < 0.001$ and $t_{147} = 8.41$, $P < 0.001$, respectively; Table 2).

The mean mass of adult Red-breasted Geese varied in each month in which they were measured (Fig. 1, Table 3). Adult male Red-breasted Geese were significantly heavier in August than in February ($t_{109} = –6.88$, $P < 0.001$). Adult female Red-breasted Geese were lightest during July, the period after incubation and during annual wing moult (Fig. 1). However, by August, the mean mass of adult females had increased and there was no significant difference in their mass between August and February ($t_{78} = –1.33$, $P = 0.09$, n.s.).

On using measurements from both summer and winter, adult male Red-breasted Geese were on average heavier (by 15.3%) and had longer wings (by 6.4%), head and bill lengths (by 4.8%) and tarsus length (by 6.8%) than adult females. First-winter males were heavier (by 10.9%) and had longer wings (by 3.8%) than first-winter females.

Change in mass during the annual wing moult

The mass of male and female adult Red-breasted Geese did not appear to change

Table 1. The number of Red-breasted Geese caught during the summer on the Taimyr Peninsula, the Gydan Peninsula and the Yamal Peninsula in Russia (in 1996, 2007, 2010 and 2012–2014) and in four cannon-net catches in Bulgaria (in winters 2010/11, 2012/13 and 2013/14), with the number of biometrics taken.

Catch area	Date	Total no. caught	No. of birds measured			
			Wing	Head & bill	Tarsus	Mass
Taimyr, Russia (adults)	6 July–13 Aug 1996	148	146	147	145	148
Taimyr, Russia (goslings)	12–13 Aug 1996	51	45	0	47	50
Taimyr, Russia	16 June–15 July 2007	13	0	0	0	13
Taimyr, Russia	June 2010	1	0	0	0	1
Gydan, Russia	9 July–21 July 2012	15	10	0	0	15
Taimyr, Russia	21 June–1 July 2013	6	0	0	0	6
Taimyr, Russia	1 July–17 July 2013	14	14	0	0	13
Yamal, Russia	5 July–17 July 2014	6	3	0	0	6
Bulgaria	11 Jan 2011	6	6	6	6	6
Bulgaria	8 Feb 2013	95	0	0	0	31
Bulgaria	9 Jan 2014	12	0	0	0	12
Bulgaria	12 Feb 2014	45	43	0	0	45
Total		**412**	**267**	**153**	**198**	**346**

with the stage of their remige re-growth (Fig. 2, Table 4). However, the breeding status of adult females (determined by the presence of brood patches and the presence of goslings in round-ups) appeared to be a relevant factor, in that the mass of successful and failed breeders did not change with the stage of remige re-growth, but the mass of non-breeders declined significantly (Fig. 3, Table 4). Goslings of both sexes showed a positive relationship between mass and the length of the remiges (Fig. 4, Table 4).

Comparison of sex determination by eversion of the cloaca and by using measurements obtained during the winter

Having established that male Red-breasted Geese were, on average, larger than females, we used flat wing length and mass, the two measurements for which we had the largest

Table 2. Summary biometrics of Red-breasted Geese caught in the summer in Russia (in 1996, 2007, 2010 and 2012–2014) and in the winter in Bulgaria (in 2011, 2013 and 2014). [(a)] = measurements of first-winter birds, taken only in Bulgaria in winter.

Measurement	Wing (mm)	Head & bill (mm)	Tarsus (mm)	Mass (g)
Adult male				
Mean ± s.e.	367.9 ± 2.6	74.8 ± 0.4	61.1 ± 0.4	1,413 ± 9
Range (min.–max.)	344–381	58.6–78.4	53.4–73.9	1,150–1,700
Sample size	14	70	70	131
Adult female				
Mean ± s.e.	345.8 ± 2.0	71.4 ± 0.2	57. 2 ± 0.2	1,225 ± 10
Range (min.–max.)	340–356	66.8–75.5	52.2–61.6	950–1,480
Sample size	8	81	79	128
First-winter male[(a)]				
Mean ± s.e.	355.0 ± 2.0	75.6	62.1	1,323 ± 18
Range (min.– Max)	340–368	75.6	62.1	1,150–1,450
Sample size	14	1	1	19
First-winter female[(a)]				
Mean ± s.e.	342.0 ± 1.8	69.8	56.5	1,193 ± 19
Range (min.–max.)	330–356	69.8	56.5	1,005–1,400
Sample size	13	1	1	18

sample sizes, to see if biometrics taken during the winter could be used to predict the sex of captured geese. We multiplied flat wing length and mass (and divided each value by 1,000) and compared these results with the sex of geese determined from eversion of the cloaca. For adults, there was complete separation, with females having values of < 470 (Fig. 5a). For first-winter birds, 12 out of 13 females (92%) had values of < 440 and 13 out of 14 males (93%) had values > 440 (Fig. 5b).

Discussion

The marking of Red-breasted Geese on the breeding grounds in northern Russia and on the wintering grounds in Bulgaria has provided an opportunity to document their measurements. These cannot be compared directly with biometrics published to date for the species because many of the earlier measurements do not differentiate between adults and first-winter birds. However, the mass of five wild Red-breasted Geese given

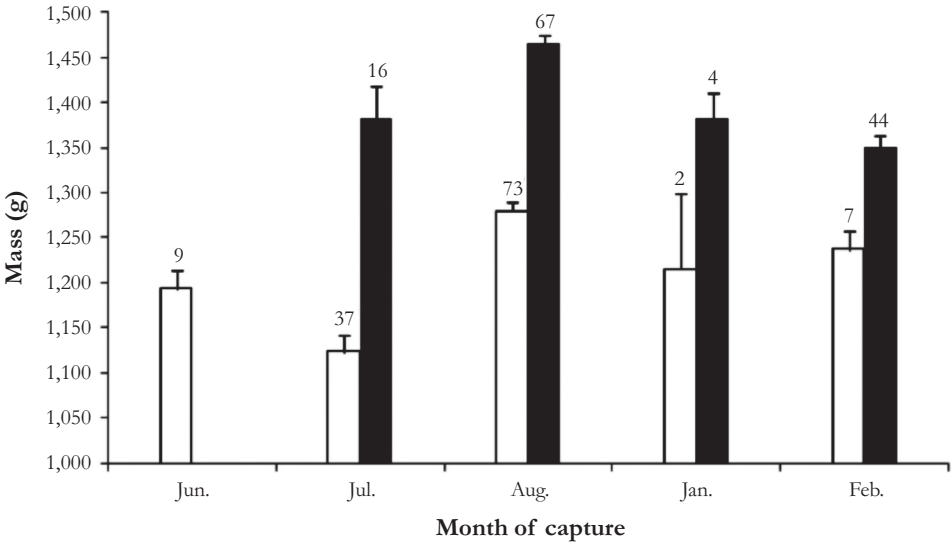

Figure 1. Mass (mean ± s.e., with sample sizes) of adult Red-breasted Geese caught in Russia (June–August) and in Bulgaria (January–February). Open column = females; closed column = males.

Table 3. Summary measurements of mass of adult Red-breasted Geese caught in the summer in Russia (1996, 2007, 2010 and 2012–2014) and in the winter in Bulgaria (2011, 2013 and 2014).

Measurement	June	July	August	January	February
Adult male					
Mean ± s.e.		1,382 ± 35	1,464 ± 10	1,382 ± 28	1,350 ± 14
Range (min.–max.)		1,150–1,700	1,290–1,660	1,300–1,420	1,200–1,625
Sample size		16	67	4	44
Adult female					
Mean ± s.e.	1,193 ± 22	1,123 ± 19	1,280 ± 10	1,215 ± 85	1,237 ± 21
Range (min.–max.)	1,100–1,300	950–1,450	1,120–1,480	1,130–1,300	1,150–1,320
Sample size	9	37	73	2	7

in Bauer & Glutz (1968) ranged from 1,200–1,625 g, similar to the mass obtained for adult males in Bulgaria. Zyryanov & Lisenko (1986) recorded that in June/July, adult males weighed 1,425g (n = 13) and adult females weighed 1,260 g (n = 11),

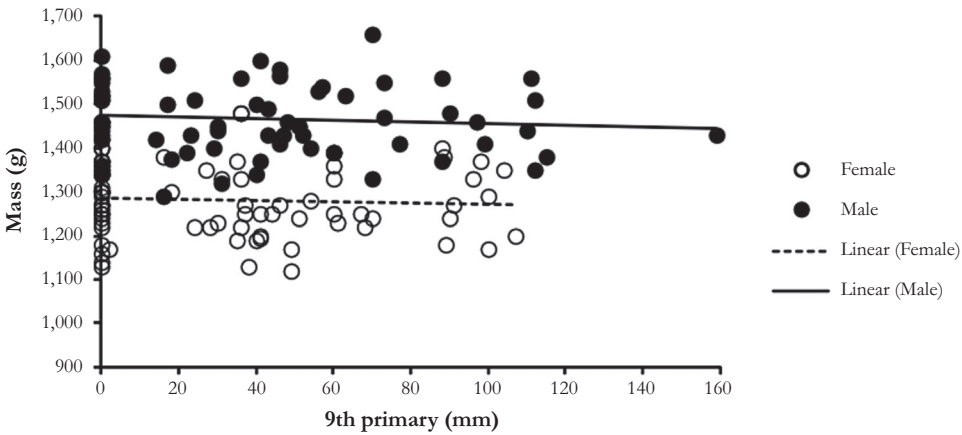

Figure 2. Relationship between 9th primary length (mm) and mass (g) of adult male (filled circles) and adult female (open circles) Red-breasted Geese caught during the annual wing moult in Russia in July and August. Linear regression lines fitted.

Table 4. Summary statistics of the relationships between the length on the 9th primary (mm) and mass (g) of Red-breasted Geese caught during the annual adult wing moult (and flightless period of goslings) in Russia in July and August.

	R^2	d.f.	F	P	Equation
Figure 2					
Adult male	0.009	1,66	0.582	0.448	y = –0.1947x + 1,473
Adult female	0.005	1,74	0.347	0.558	y = –0.1649x + 1,286
Figure 3					
Successful females	0.016	1,23	0.368	0.550	y = 0.3308x + 1,270
Failed breeding females	0.001	1,27	0.025	0.876	y = 0.0767x + 1,283
Non-breeding females	0.179	1,20	4.463	0.049	y = –1.045x + 1,322
Figure 4					
Gosling male	0.774	1,22	75.525	<0.001	y = 4.9708x + 508
Gosling female	0.790	1,13	48.866	<0.001	y = 4.1623x + 480

which declined to 1,090g during the hatching period. This decrease in mass amongst adult females, just prior to wing moult, is similar to our findings (Fig. 1), although it is thought that they quickly regain mass by August.

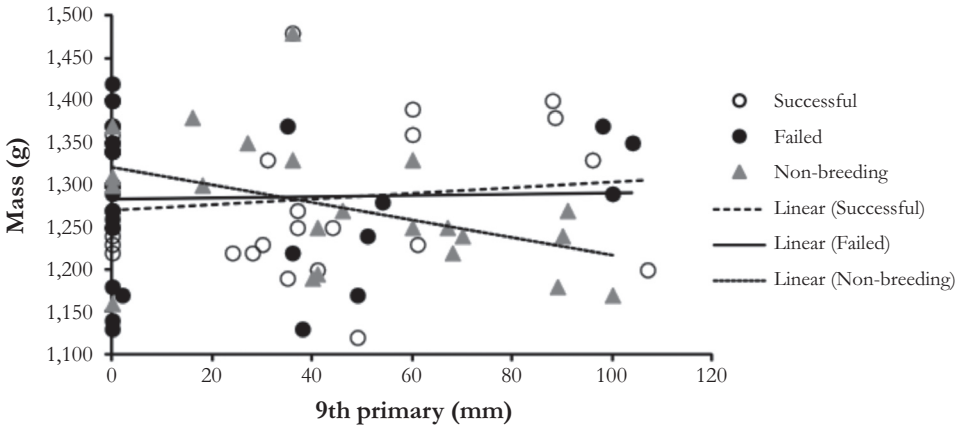

Figure 3. Relationship between 9th primary length (mm) and mass (g) of adult female Red-breasted Geese with brood patch and young present in catch (filled circles, presumed successful breeders), with brood patch and no young in catch (open circles, presumed failed breeders) and with no brood patch (triangles, presumed non-breeders) caught during the annual wing moult in Russia in July and August. Linear regression lines fitted.

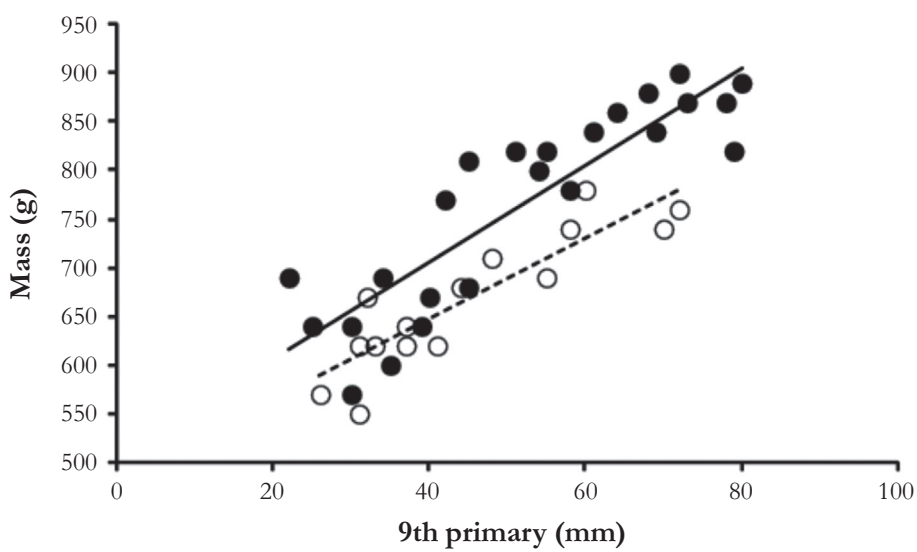

Figure 4. Relationship between 9th primary length (mm) and mass (g) of male (filled circles) and female (open circles) Red-breasted Goose goslings caught during flightless roundups in Russia in July and August. Linear regression lines fitted.

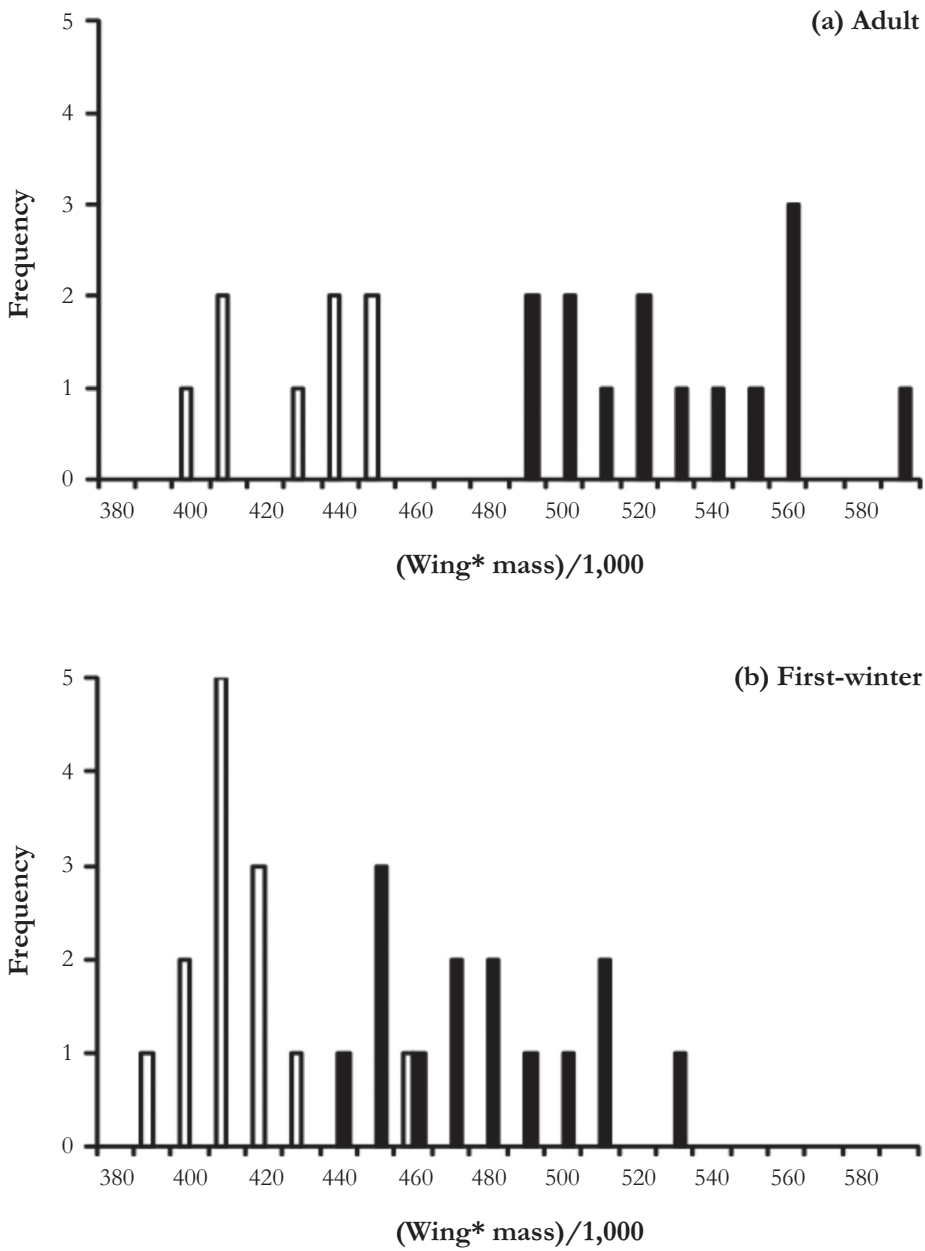

Figure 5. Frequency distribution of measurements of (wing x mass)/1,000 amongst (a) adult, and (b) first-winter Red-breasted Geese caught in Bulgaria in winters 2010/11–2013/14. Open column = females; closed column = males.

Differences in the mean biometric data for free-living Red-breasted Geese suggest that they are sexually dimorphic, with males being larger and heavier than females and adults being larger and heavier than first-winter birds. This is consistent with other species of geese (see Appendices 2 and 3 in Owen 1980).

Documenting data on mean mass is important when considering deploying telemetry devices. Current best practice suggests that telemetry devices should be no greater than 3–5% of body mass (Murray & Fuller 2000; Barron *et al.* 2010). For adult Red-breasted Geese, the lowest mean mass was 1,350g for males in February and 1,123 g for females in July. This therefore suggests that devices (including any associated attachments, straps, *etc.*) should weigh no more than 40.5–67.5 g for males and 33.7–56.2 g for females if fitted to adult Red-breasted Geese, and even then only the largest (heaviest) individuals should be fitted with devices.

In Red-breasted Geese, body mass generally appeared to remain constant during the wing moult, suggesting that the birds do not suffer nutritional stress nor do they deplete energy stores (in the sense that they burn stored fat to meet the needs of feather replacement) during the re-growth of remiges. That is to say, the nutritional and energetic needs of the geese during moult can be met from the energy within their diet. A similar pattern was observed for adult Greenland White-fronted Geese *Anser albifrons flavirostris* and Canada Geese *Branta canadensis* captured in west Greenland, where the energy requirements of the geese during moult appeared to be met from exogenous sources (Fox *et al.* 1998). However, the mass of apparently non-breeding female Red-breasted Geese was found to decline, albeit the sample size was small and the trend only just reached statistical significance. The breeding status of the individual geese and their mass at the start of the moult may therefore have an important bearing on mass change during moult (Fondell *et al.* 2013). In Svalbard Barnacle Geese *Branta leucopsis*, the energetic costs of moulting were probably < 10% of daily energy requirements and Owen & Ogilvie (1977) reasoned that the geese should be able to maintain their weight. These authors also found, however, that non-breeding females lost a significant amount of mass during the moult (as did adult males of unknown breeding status), which may suggest that the birds depleted fat stores in the body accumulated to provide some insurance against unfavourable feeding conditions, for instance through poor sources of energy in food, competition with breeding birds, or low temperatures during the moult. Breeding Barnacle Geese did not conform to this pattern because they were heavier at the same moult stage than non-breeders. Body weight of mostly non-breeding, moulting adult Barnacle Geese in Kolokolkova Bay, Russia also declined markedly during moult, at an average of *c.* 15 g per day for both males and females (van der Jeugd 2003).

Our study suggests that a simple metric (multiplying flat wing length and mass) could be used for sex determination in non-moulting adult Red-breasted Geese with up to 100% accuracy and amongst first-years with approximately 90% accuracy compared

with cloacal eversion. This method of sex determination might be considered if fieldworkers without training in cloacal sexing were to undertake catches of Red-breasted Geese. However, if this metric is used to assign a sex, the method should be recorded in any publications. Certainly a far greater number of measurements (matched with results from eversion of the cloaca) need to be gathered to see if the pattern of segregation persists in larger samples.

The current conservation status of Red-breasted Geese (globally Endangered on the IUCN Red List; BirdLife International 2015) means that it is receiving more attention from researchers, and continued ringing of wild birds for conservation research should increase the number of measurements recorded. It is recommended that the biometric data collected should follow those suggested by Dzubin & Cooch (1992). Through contacts within the Wetlands International/IUCN-SSC Goose Specialist Group, biometric data from any birds caught for ringing and any geese shot illegally could be pooled to increase the knowledge base for this species. Anyone with knowledge of published biometric data for Red-breasted Geese, or anyone who holds data from caught live birds and wishes to share those data, are therefore encouraged to contact the correspondence author.

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Photograph: Red-breasted Geese, with a few European White-fronted Geese, in snowy conditions in Bulgaria, by Daniel Mitev.

Photograph: Releasing Red-breasted Geese caught and ringed in Bulgaria in February 2013, by Marina Georgieva. From left to right: Nicky Petkov, Anne Harrison, Bob Swann, Kane Brides and Peter Cranswick.

