Incidence of embedded shotgun pellets and inferred hunting kill amongst Russian/Baltic barnacle geese *Branta leucopsis*

Thomas Eske Holm · Jesper Madsen

Received: 23 February 2012 / Revised: 9 June 2012 / Accepted: 20 June 2012 / Published online: 10 July 2012
© Springer-Verlag 2012

Abstract X-rays of wild caught barnacle geese from the Russian/Baltic population were taken in Denmark in the springs of 2009 and 2011 to determine the incidence of embedded shotgun pellets and to estimate the annual hunting kill. On average, 13 % of adult geese ($n=212$) and 6 % of first year geese ($n=35$) examined contained pellets in their tissue. Assuming that these birds represented a random sample, extrapolation to the entire population of c. 770,000 individuals indicates that 96,000 barnacle geese carry embedded pellets. Based on the assumption that the ratio between the number of birds with embedded shot and the total number of birds harvested per season is similar to that found in pink-footed geese *Anser brachyrhynchus* (recorded as 3.6:1 during 1990–1996 and 1.7:1 during 2009–2011), the annual kill of barnacle geese was estimated at 26,300–58,300 birds. The Russian/Baltic barnacle geese are protected from hunting on their winter quarters (The Netherlands, Germany and Denmark), but are quarry in Russia and are shot under license to protect agricultural crops in Estonia, Germany, Sweden and Denmark (amounting to a total of c. 1,800–3,000 geese shots per year). Barnacle geese are known to be shot illegally (accidentally and deliberately) along the migration route, but in the absence of Russian bag statistics, the contribution of illegal hunting to the overall harvest cannot be substantiated. Although the population is currently increasing at an annual rate of 8 %, the indirectly estimated hunting pressure (3–7 %) is not insubstantial and should be taken into account in future population management models.

Keywords Crippling · Pink-footed geese · Hunting bag · Infliction rate · Harvest rate · X-ray

Introduction

Mortality rates are important in the management of goose populations. Small fluctuations in adult survival of these relatively long-lived species have a more profound effect on overall population size, than relatively large-scale changes in breeding output (Fox and Madsen 1999; Sæther and Bakke 2000). There are relatively few goose populations in the Western Palaearctic for which precise mortality rates exist, and since a very high proportion of mortality is caused by shooting, it is becoming even more vital that assessment of the size of the hunting bag is made for all species (Fox and Madsen 1999).

The use of X-ray images to determine the incidence of embedded shotgun pellets provides some insight into the exposure of a population to hunting where hunting statistics are inadequate or non-existence. The use of shotguns inevitably causes non-lethal wounding of birds that are inflicted but not killed by pellets. X-ray investigations have shown that between 28 and 62 % of quarry geese carried shotgun pellets (Elder 1950, 1955a, b; Grieb 1970; Jönsson et al. 1985; Noer and Madsen 1996; Norman 1976), and even amongst protected swans, 14–31 % carried embedded pellets (Andersen-Harild et al. 1982; Newth et al. 2011). However, infliction rates have rarely been used to estimate actual hunting bags.

The Russian/Baltic breeding population of barnacle geese breeds in arctic Russia and on islands in the Baltic (Ganter et al. 1999). The population has increased from c. 10,000 birds in the 1950s (Boyd 1961) to c. 770,000 birds in 2008 (Fox et al. 2010). From the Russian breeding grounds, the geese migrate via the Baltic, staging in Estonia, on Gotland, Øland

Communicated by C. Gortázar

T. E. Holm (✉) · J. Madsen
Department of Bioscience, Aarhus University,
Grenaaavej 14,
8410 Roende, Denmark
e-mail: teh@dmu.dk

and in south Sweden, to winter in Denmark, Germany and The Netherlands. Dramatic increases in population size have led to conflicts between agriculture and geese throughout the wintering range and staging grounds (Ganter et al. 1999). The barnacle goose is protected throughout its wintering range, but has an open season in Russia (autumn and spring). However, numbers shot is unclear since no hunting bag statistics exist for Russia (K. Litvin, personal communication). Due to agricultural conflicts, barnacle geese are shot under license to protect vulnerable crops and grasslands in Sweden (c. 200–400 per year; The Gotland County Administrative Board, unpublished; K. Larsson, personal communication), Estonia (c. 1,000–2,000 per year; K. Roht, Estonian Ministry of Environment, personal communication), Denmark (up to 30 per year, National Nature Agency, unpublished data) and Germany (c. 600 per year, MLURLS-H 2008). In addition, wildlife managers and observers in Denmark report that increasing numbers of barnacle geese have been shot illegally in recent years (T.E. Holm and J. Madsen, unpublished data).

In this study, we investigate (1) the exposure to hunting of Russian/Baltic barnacle geese *Branta leucopsis* by investigating the incidence of embedded shotgun pellets, and (2) based on data from a study of pink-footed geese *Anser brachyrhynchus*, we also indirectly attempt to estimate the annual hunting kill.

Material and methods

The geese were caught by cannon-net, in areas baited with grain, at Vest Stadil Fjord, West Jutland, Denmark, in late March 2009 and 2011. The primary objective was to monitor the infliction rate of shotgun pellets in pink-footed geese, as part of a national management plan to reduce crippling in quarry wildlife (Elmeros et al. 2012; Noer et al. 2007). Due to the increase in population size, barnacle geese have become increasingly abundant at the site in recent years and, therefore, were also caught and X-rayed. Geese were aged as ‘first year’ birds (i.e. had survived one hunting season) and ‘older’ (exposed to two or more hunting seasons) from their plumage characteristics; barnacle geese moult into adult plumage during their second summer.

A mobile surgical X-ray unit with screen and printer was used for examinations. Geese were hooded and wrapped in cloth to restrain them whilst being X-rayed. When present, pellets were easily distinguished in the photographs. Records were screened for shot in the gizzard or oesophagus that could have been ingested rather than inflicted (Noer and Madsen 1996).

Assuming our samples represented a random sample, extrapolated to the entire population of c. 770,000 individuals, we calculate the total number of injured individuals in

the population, based on the age-specific infliction rates and age composition. Assuming that the ratio between the number of crippled individuals in the population and the annual hunting bag is equivalent to that in pink-footed geese, we can then estimate the hunting kill for barnacle geese. The annual hunting bag for pink-footed geese was derived from the official national bag statistics in Norway and Denmark (www.stat.no; www.vildtudbytte.dk). Population size and productivity estimates of pink-footed geese (the proportion of juveniles in the autumn population) were derived from the database of annual survey results held at Aarhus University (J. Madsen, unpublished data). Data on infliction rate of pink-footed geese were provided by the national monitoring programme to reduce crippling in wildlife (Elmeros et al. 2012; Holm et al. 2011; Noer et al. 2007). Following the introduction of the national action plan to reduce crippling in 1997, there was a significant reduction in infliction rates after 1997 (Holm et al. 2011). We have therefore calculated the ratio between the number of crippled and killed pink-footed geese on the basis of data from before the implementation of the plan (1990–1996) and in recent years (2009 and 2011). Data on population size for barnacle geese were taken from Fox et al. (2010) and productivity estimates for 2009–2011 were provided by K. Koffijberg, SOVON/Goose Specialist Group, The Netherlands (unpublished data). To test for differences in infliction rates between years, a chi-square test with a Yates's correction was used.

Results

The proportion of first-winter barnacle geese with embedded pellets was 1 out of 18 (5.6 %) in 2009 and 1 out of 17 (5.9 %) in 2011. In 2009, 13 out of 93 (14.0 %) older birds were recorded with pellets, whereas in 2011, 15 out of 119 (12.6 %) carried embedded shot, with no differences between years (first year: $\chi^2=0.53$, $df=1$, $P>0.05$; older: $\chi^2=0.12$, $df=1$, $P>0.05$). Average infliction rates in first year and older geese were 5.7 % $\pm$ 0.2 SD and 13.3 % $\pm$ 1.0 SD, respectively. The number of pellets in first year geese ranged between 1 and 2 (average 1.5 $\pm$ 0.7 SD) and in older geese between 1 and 4 (average 1.3 $\pm$ 0.7 SD).

Table 1 shows calculations of the ratio between total number of inflicted pink-footed geese and hunting kill during 1990–1996 and 2009–2011, based on X-ray data, population data and bag statistics. The ratio decreased from 3.6:1 to 1.7:1 between the two periods which was primarily ascribed to a reduction in the crippling rates as a positive result of the national management plan to reduce crippling (see Noer et al. 2007 for details). When infliction rates in barnacle geese were extrapolated to the entire population, the total number of barnacle geese carrying shotgun pellets was calculated as being 95,957 (Table 1). If we assume that

Table 1 Calculation of the total number of pink-footed geese and barnacle geese with pellets and the estimated hunting bag for barnacle geese

	Pink-footed goose, 1990–1996	Pink-footed goose, 2009–2011	Barnacle goose, 2009–2011
Population size	32,000	65,000	770,000
Proportion of juveniles	0.168	0.153	0.111
Number of juveniles	5,376	9,945	85,470
Number of adults	26,624	55,055	684,530
Proportion of juveniles with pellets	0.25	0.079	0.0575
Proportion of adults with pellets	0.36	0.225	0.133
Number of juveniles with pellets	1,344	786	4,915
Number of adults with pellets	10,929	12,387	91,042
Total number with pellets	10,929	13,173	95,957
Hunting bag	3,000	8,000	26,341–58,275
Ratio of total number with pellets/bag	3.64:1	1.65:1	

The hunting bag for barnacle geese was calculated assuming that the ratio between number of crippled vs. number harvested was similar to what was found in pink-footed geese. For pink-footed geese, data are presented from before and after a national action plan to reduce crippling

the ratio between the number of crippled individuals and the annual hunting bag was within the range of that calculated for pink-footed geese, the annual hunting bag of barnacle geese is estimated to be between c. 26,300 and 58,300 individuals.

Discussion

The proportion of barnacle geese with embedded shotgun pellets is comparable with crippling rates found in protected swans (Newth et al. 2011) but lower than previously reported from quarry geese. Nevertheless, the estimated hunting bag is surprisingly high for a species that is not on the EU Birds Directive's Annex II of huntable species and for which hunting is not permitted in the EU member states. However, according to the EU Birds Directive's Article 9, dispensation can be given to regulate the species by shooting in areas where it causes damage to farmland crops, and it appears that between 1,800 and 3,000 barnacle geese are shot under such dispensations annually. Barnacle geese have an open season in Russia, but there is no official information available about the size of the kill. Russian goose experts judge that only a few thousand barnacle geese are shot annually because many settlements in the Russian Arctic have been completely abandoned and the number of inhabitants has decreased dramatically (K. Litvin and P. Glazov, personal communication). If this holds true, there is a discrepancy between the total number of geese shot and the kill estimated from this study. This estimate is based on the assumptions (1) that the sample of X-rayed birds is representative of the population as a whole and (2) that the ratio between the number crippled and number harvested is comparable to that found in pink-footed

geese. Since X-ray examinations have only been performed at one site and only in Denmark, we cannot substantiate the former assumption and we have no data to inform to what extent the population mixes on the wintering and spring staging areas. Potentially, the sample could be biased if the barnacle geese staying in Denmark during spring also occur there during autumn because this would expose them to accidental hunting in flocks mixed with pink-footed geese. However, numbers of barnacle geese increase dramatically during spring (J. Madsen, unpublished data) which is most likely to be birds coming from wintering grounds in The Netherlands and Germany. Therefore, we regard the potential bias as minor. With regard to the latter assumption, the ratio for pink-footed geese calculated for the two time intervals shows that it varied greatly. Between the two time intervals, the national action plan to reduce crippling was introduced and the decrease in ratio was largely attributed to improved hunter performance, i.e. better awareness of shooting at shorter range and better shooting practise in general (Noer et al. 2007). Because there has been no campaign to address hung crippling outside Denmark, we believe that the upper ratio is the most realistic to apply to barnacle geese, which suggests a kill of around 26,000 geese per year. However, barnacle geese are smaller than pink-footed geese; at time of the catch in spring, adult males weighted on average 1,810 and 2,746 g, respectively. This means that they are more likely to be killed by shotgun pellets (assuming that the ammunition used to shoot the two species is similar). This will decrease the ratio between the number of crippled and killed, resulting in a higher estimated kill.

Another explanation that can contribute to the high kill and infliction rate is that a substantial number of barnacle geese are shot illegally. Several cases of illegal hunting of barnacle geese have been documented in Denmark, and

hunters have explained that they have mistaken barnacle geese for quarry Canada geese *Branta canadensis*. Furthermore, barnacle geese may be shot inadvertently when they fly in flocks mixed with other quarry goose species or during dawn and dusk when it may be difficult to discriminate goose species. The increase in population size has led to a rapid increase in numbers and expansion in the spatial distribution of the species and barnacle geese have now dispersed into the traditional staging areas for pink-footed geese in western Denmark. The two species are often seen in mixed flocks and the risk of bringing down or wounding barnacle geese when hunting for pink-footed geese has therefore increased significantly during the last decade. However, deliberate poaching of barnacle geese has also been observed.

The infliction rate of barnacle geese is most likely due to a mixture of legal and illegal shooting. However, as long as we do not have bag statistics from Russia, we cannot substantiate the contribution of illegal shooting to the overall bag. X-ray studies of fully protected swans showed that illegal shooting caused crippling rates of 14–31 % (Andersen-Harild et al. 1982; Newth et al. 2011), suggesting that this may also make a substantial contribution in the barnacle geese. This calls for improved goose species recognition skills (visual as well as auditory) among hunters to minimise the risk for look-a-like misidentifications and shooting into mixed flocks. The fact that the population of barnacle geese is increasing at an annual rate of 8 %, Fox et al. (2010) suggest that the current hunting pressure (3–7 %) is sustainable, although of sufficient significance that it has to be taken into account in future population management models.

Acknowledgments The Danish Nature Agency is thanked for granting access to catch geese at Vest Stadil Fjord. Peter Glazov, Konstantin Litvin, Aivar Leito, Karel Roht, Kjell Larsson and the Gotland County Administrative Board are thanked for providing unpublished information on shooting and Kees Koffijberg for providing unpublished productivity data.

References

- Andersen-Harild P, Clausen B, Elvestad K, Preuss NO (1982) Lead pellets in tissues of mute swans (*Cygnus olor*) from Denmark. Danish Rev Game Biol 12:1–12
- Boyd H (1961) The number of barnacle geese in Europe 1959–1960. Wildfowl Trust Annu Rep 12:116–124
- Elder WH (1950) Measurement of hunting pressure in waterfowl by means of X-ray. Transactions of the 15th North American Wildlife Conference, March 1950, San Francisco, pp. 490–504
- Elder WH (1955a) Fluoroscopic measurements of shooting pressure on pink-footed and greylag geese. Wildfowl Trust Annu Rep 7:123–126
- Elder WH (1955b) Fluoroscopic measures of hunting pressure in Europe and North America. Transactions of the 20th North American Wildlife Conference, March 1955, Montreal, pp. 298–321
- Elmeros M, Holm TE, Haugaard L, Madsen AB (2012) Prevalence of embedded shotgun pellets in protected and legally hunted medium-sized carnivores in Denmark. Eur J Wildl Res. doi:10.1007/s10344-012-0621-7
- Fox AD, Madsen J (1999) Introduction. In: Madsen J, Cracknell G, Fox AD (eds) Goose populations of the Western Palaearctic: a review of their status and distribution: Wetlands International, Wageningen, The Netherlands. National Environmental Research Institute, Aarhus, pp 8–18
- Fox AD, Ebbinge BS, Mitchell C, Heinicke T, Aarvak T, Colhoun K, Clausen P, Dereliev S, Farago S, Koffijberg K, Kruckenberg H, Loonen M, Madsen J, Mooij J, Musil P, Nilsson L, Pihl S, van der Jeugd H (2010) Current estimates of goose population sizes in the Western Palearctic, a gap analysis and assessment of trends. Ornithol Monogr 20:115–127
- Ganter B, Larsson K, Syroechkovsky EV, Litvin KE, Leito A, Madsen J (1999) Barnacle goose *Branta leucopsis*: Russia/Baltic. In: Madsen J, Cracknell G, Fox AD (eds) Goose populations of the Western Palaearctic: a review of their status and distribution: Wetlands International, Wageningen, The Netherlands. National Environmental Research Institute, Aarhus, pp 270–283
- Grieb JR (1970) The shortgrass prairie Canada goose population. Wildlife Monogr 22:1–47
- Holm TE, Madsen J, Haugaard L, (2011) Anskydning af vildt. Nye undersøgelser 2008–2011. Nationalt Center for Miljø og Energi, Aarhus Universitet. Teknisk rapport fra Nationalt Center for Miljø og Energi nr. 1
- Jönsson B, Karlsson J, Svensson S (1985) Incidence of lead shot in tissues of the bean goose (*Anser fabalis*) wintering in South Sweden. Swedish Wildl Res 13:259–271
- MLURLS-H, (2008) Jagd und Artenschutz. Jahresbericht 2008. Ministerium für Landwirtschaft, Umwelt und ländliche Räume des Landes Schleswig-Holstein
- Newth JL, Brown MJ, Rees EC (2011) Incidence of embedded shotgun pellets in Bewick's swans *Cygnus columbianus bewickii* and whooper swans *Cygnus cygnus* wintering in the UK. Biol Cons 144:1630–1637
- Noer H, Madsen J (1996) Shotgun pellet loads and infliction rates in pink-footed goose *Anser brachyrhynchus*. Wildl Biol 2:65–73
- Noer H, Madsen J, Hartmann P (2007) Reducing wounding of game by shotgun hunting: effects of a Danish action plan on pink-footed geese. J Appl Ecol 44:653–662
- Norman FI (1976) The incidence of lead shotgun pellets in waterfowl (Anatidae and Rallidae) examined in South-Eastern Australia between 1957 and 1973. Aust Wildl Res 3:61–71
- Sæther BE, Bakke Ø (2000) Avian life history variation and contribution of demographic traits to the population growth rate. Ecology 81:642–653