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Neck collar retention in a Greylag Goose *Anser anser* population

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Abstract

A total of 179 recaptures, obtained one to eleven years after collar placement, was used to estimate neck collar retention rates in a marked breeding population of Greylag Goose *Anser anser* in Scania, southernmost Sweden. Owing to a very high year-round re-sighting frequency, all calculations were made on the total time neck collars had been exposed to potential losses. The overall annual neck collar retention rate was 97.1±0.7%. The annual loss rate was four times higher in males than in females (5.5±1.5% vs 1.4±0.5%), twice as high among birds collared as goslings than among those collared as breeders, both in males (8.4±4.0% vs 4.6±1.6%) and in females (1.7±0.9% vs 0.7±0.7%) and markedly higher among individuals wintering in south-western Spain than among those spending the winter elsewhere, both in males (9.1±3.1% vs 2.5±1.4%) and in females (2.3±1.1% vs 0.6±0.6%). Shooting was the main cause of neck collar loss, but most collars did not actually fall off until during the following breeding season. Suggestions are presented of how these results ought to influence the analysis of survival rates based on re-sightings of neck-collared individuals from this population.

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Introduction

The use of neck collars to mark geese individually has become a common technique to study migration, behaviour and population dynamics (*e.g.* Rusch *et al.* 1998). In the Greylag Goose *Anser anser*, re-sightings of neck-collared individuals from a breeding population in Scania, southernmost Sweden, have been used to estimate various population parameters, including survival rates (Nilsson & Persson 1993, 1996, Persson 1996, Nilsson *et al.* 1997). In these studies, no correction for marker loss was made due to a low rate of collar loss and the replacement of broken or lost collars on recaptured individuals (Nilsson & Persson 1993). However, collar loss results in an underestimate of survival rates and a loss of precision. Marker loss may be important in studies of potentially long-lived species, especially if loss rates vary due to sex, age of bird at collaring, collar type, age of collar and migration strategy.

This is the first attempt to analyse neck collar retention rates in a marked Greylag Goose population in southernmost Sweden. The main objective of the analysis was to provide future guidelines for field work and the analysis of survival rates.

Material and methods

The capture of Greylag Goose families for neck-collaring has been undertaken annually in a study area in south-western Scania, southernmost Sweden since 1985 (Persson 1994). For a description of the study area, see Nilsson & Persson (1992). Including a pilot catch in 1984, a total of 575 adults and 1700 goslings was fitted with engraved plastic collars as well as standard metal rings up to 2000 (Persson 2000).

To determine collar retention rates, only re-trapped birds were included in the analyses. This resulted in a smaller sample, but eliminated the bias of field observation towards marked birds. In the catching method used, the likelihood of a previously neck-collared individual being re-trapped was independent of whether or not the bird still wore the neck collar

(Persson 1994). Broken collars were replaced on recaptured individuals by routine.

The first generation of neck collars used in the project was of an inferior quality, resulting in an exceptionally high loss rate among males. For that reason, all individuals marked with such collars were excluded from the analyses. The remaining neck collars were supplied by three different manufacturers. Collars from the first were used throughout the study period, from the second only on goslings and from the third only since 1997. These collars were analysed together.

Owing to very high re-sighting frequency all year round (Nilsson & Persson 1993) the interval during which a re-trapped bird had lost its collar could be narrowed down to between two and forty-six days for all individuals but two. The latter two lost their collars during a four-month period. The midpoint of each bird's interval was chosen as the day of neck collar loss (Mayfield's midpoint assumption; Mayfield 1961) and used for the subsequent calculations. Therefore, neck collar loss rate could be calculated based on the total time the neck collars had been exposed to potential losses, instead of the total time elapsed between collar placement and recapture. With the Mayfield method, annual loss rate is estimated by dividing number of neck collar losses by number of exposure years (number of exposure days divided by 365.25) for recaptured individuals (*cf.* Johnson 1979). Metal ring loss was calculated in the same way. Rates are given with standard error. Statistical tests of differences in loss rates among different segments of the marked population were beyond the scope of this analysis.

Results

A breakdown of the 179 re-traps by the number of years since collar placement, age of bird at collaring and sex is shown in Table 1. The number of re-traps was too low to allow statistical analyses (*cf.* Samuel *et al.* 1990) but overall, the data do not indicate an increased loss rate with collar age.

It is not necessary to account for individuals having lost both neck collar and metal ring before being recaptured, as the annual metal ring retention rate (sexes and age groups combined) was as high as 99.64±0.25% (based on 558.1 metal ring years).

The overall annual neck collar retention rate (sexes and age groups combined) was 97.1±0.7% (based on 589.9 neck collar years; 'years' hereafter). The annual loss rate was four times higher in males than in

Table 1. Number of males and females, collared as goslings and breeders respectively, still wearing neck collars recaptured in different years after neck-collaring. Number of individuals that lost their neck collar before recapture is given in brackets. For the latter group, the year of neck-collar loss is indicated (and not the year of recapture). The table is based on re-traps made in Scania during the years 1987–2000.
Antal hanar och honor, märkta som gässlingar respektive häckare, som med halsringen i behåll återfångades olika antal år efter märkningen. Inom parentes anges hur många individer som hade tappat sina halsringar innan de återfångades. För den sistnämnda gruppen anges året de tappade halsringen (och inte året de återfångades). Tabellen baseras på återfångster gjorda i Skåne under åren 1987–2000.

Years after neck-collaring *Antal år efter halsringmärkning*	Goslings *Gässlingar*		Breeders *Häckare*		Total *Totalt*
	Males *Hanar*	Females *Honor*	Males *Hanar*	Females *Honor*	
1	4(1)	3	17(2)	19(1)	43(4)
2	1(1)	1(2)	19(2)	14	35(5)
3	2	8	7	6	23
4	(1)	7(2)	5(2)	3	15(5)
5	2	5	6(1)	6	19(1)
6	1	4	2	3	10
7	1(1)	4	(1)	1	6(2)
8		2			2
9		3		1	4
10		3			3
11		1	1		2
Total *Totalt*	11(4)	41(4)	57(8)	53(1)	162(17)

females, 5.5±1.5% (220.0 years) vs 1.4±0.5% (369.8 years). The rate was also higher among birds collared as goslings than those collared as breeders, both in males (8.4±4.0% (47.8 years) vs 4.6±1.6% (172.2 years)) and in females (1.7±0.9% (228.7 years) vs 0.7±0.7% (141.1 years)).

The annual loss rate was markedly higher among individuals wintering in south-western Spain than among those spending the winter elsewhere (mainly the Netherlands and north-central Spain), both in males (9.1±3.1% (87.8 years) vs 2.5±1.4% (118.6 years)) and in females (2.3±1.1% (176.5 years) vs 0.6±0.6% (176.4 years)).

Two of the 17 birds that lost its neck collar before being recaptured lost it during the period from the end of October to the end of February. All but one of the other 15 birds lost its collar during the first half of the breeding season, from the beginning of February to about 20 April. The exception was a bird that lost its collar in October or early November.

In the course of the study, 16 individuals got their collars replaced; eleven collars had been hit by shot-gun pellets (seven worn by females and four by males), three were broken of unknown cause (two worn by females and one by a male), while two were insufficiently glued (one worn by each sex). Of those ten individuals with known winter quarters that got their collars replaced after hits by shot-gun pellets, 70% wintered in the Guadalquivir Marismas. These replacements might have biased the results as one of the males was recaptured once more. If this bird, without the replacement, had lost its collar during the following breeding season, the annual neck collar loss rates should have been higher for the following groups of birds (the higher values are given within brackets): overall (3.1±0.7%), males (6.0±1.6%), males marked as adults (5.3±1.7%) and males wintering in the Guadalquivir Marismas (10.2±3.2%).

Discussion

The neck collar retention rate observed in this study is one of the highest ever recorded. In the Canada Goose *Branta canadensis*, Hestbeck (1994) calculated an annual retention rate of 98.8% for a population in the Atlantic Flyway, while rates of about 80% were found for birds in the Mississippi Flyway (Craven 1979, Trost 1983, Samuel *et al.* 1990). Other published rates are 97% for the Greater Snow Goose *Anser caerulescens atlantica* (Menu et al. 2000), 95.5% for the Pacific White-fronted Goose *Anser albifrons frontalis* (Schmutz & Ely 1999), 87.5% for the female Dusky Canada Goose *Branta canadensis occidentalis* (Campbell & Becker 1991), 75% for the Cackling Canada Goose *Branta canadensis minima* (Raveling et al. 1992) and 68% for the Lesser Snow Goose *Anser caerulescens caerulescens* (Johnson *et al.* 1995).

One reason for the observed differences in retention rates may be differences in behaviour, temperament and bill structure among species and populations. Lesser Snow Geese (MacInnes *et al.* 1969) and Taiga Geese *Anser fabalis* (pers. obs.) vigorously chew their collars, which neither the Canada Geese (Fjetland 1973) nor the Greylag Geese (pers. obs.) do.

More important, however, is that a wide variety of collar materials and attachment techniques have been used (see for example, Samuel *et al.* 1990). For instance, the first generation of neck collars used in the Nordic Greylag Goose Project turned out to be very sensitive to ultraviolet radiation. As a consequence, males started to lose their collars in numbers already after eight months. This kind of collars was phased out during 1986. Among the neck collars used in Scania since then, there may be differences in retention rates depending on the manufacturer. For the time being, however, the number of re-traps is much too low to allow analyses of the three different collar types separately.

In several studies, annual neck collar loss rate increased with collar age (Fjetland 1973, Raveling 1978, Craven 1979, Wilson *et al.* 1991, Nichols *et al.* 1992, Johnson *et al.* 1995, Hines *et al.* 1999), while such an effect was not found by others (Zicus & Pace 1986, Hestbeck & Malecki 1989, Campbell & Becker 1991, Raveling *et al.* 1992, Hestbeck 1994). An increased loss rate might be caused by an accumulation of small chips and cracks over the years, finally leading to collar breakage, as discussed by MacInnes & Dunn (1988). Such an ageing effect is not evident in the Scanian population, but it cannot be ruled out totally based on the existing data.

Shooting has been singled out as the main cause of neck collar loss, due to collar breach when hit by pellets (Wilson *et al.* 1991). In the Greenland White-fronted Goose for instance, most collars were first noted missing during the winter of 1985/86, the only period when shooting in Ireland was permitted (Wilson *et al.* 1991). In the present study, the results strongly indicate that shooting is the main cause of collar loss. This is supported by the fact that most replacements during the study period were due to collars having been hit by shot-gun pellets. The higher loss rate among individuals wintering in south-western Spain can be related to a markedly higher hunting pressure in the Guadalquivir Marismas than in other winter quarters used by this population (Nilsson & Persson 1996, Persson 1996, 1999).

In most cases, several months, or even years, elapse from the moment a collar is hit by a shot-gun pellet until it actually falls off. This interpretation is fully supported by field observations in Scania, as well as abroad (Nilsson & Persson unpubl. data). The large difference in annual loss rate between the sexes is harder to explain. It is true that more females than males got their collars replaced after being hit by shot-gun pellets but if exposure time is taken into account, there is no longer any difference between the sexes. A possible explanation is that hunters preferentially fire at adult males, especially when shooting at a long range, giving ample time to single out the largest target. Such a selective harvesting of adult males was found among sportsmen hunting Taiga Geese at Trolle-Ljungby (pers. obs.).

In general, females retain their collars at a higher rate than males (Fjetland 1973, Johnson & Sibley 1989, Samuel *et al.* 1990, Campbell & Becker 1991, Nichols *et al.* 1992, Johnson *et al.* 1995, Hines *et al.* 1999, this study; but see Craven 1979, Zicus & Pace 1986, Hestbeck & Malecki 1989). Trost (1983) suggested that this sex-related difference was the result of increased aggressiveness among males, primarily during courtship and territorial defence. The fact that nearly all recorded neck collar losses among the Scanian Greylag Geese occurred during the first half of the breeding season lends support to this hypothesis. Further support comes from Johnson *et al.* (1995), who reported that most neck collar losses in the Lesser Snow Goose occurred during a brief period each year, with almost 60% of all lost neck collars being found at the breeding colony. Apparently, hunting pressure and aggression act in combination to cause the high loss rate among Scanian Greylag Goose males wintering in south-western Spain.

In most studies, a higher loss rate among juveniles than among adults may be attributed to collars slipping over the smaller heads of goslings, as suspected by Samuel *et al.* (1990). That explanation is not applicable to the Scanian Greylag Geese, however, as no bird lost its collar until more than six months after collar placement. Nor can the age difference be explained by a higher susceptibility to shooting during the first year after collar placement (Persson 1996). Instead, the explanation must be sought during the period running from the bird becoming independent from its parents until becoming established as a breeder. During this period the geese, especially the males, move around much more than later in life, prospecting potential breeding, moulting, staging and wintering areas (Nilsson & Persson 1992, and unpublished). In that way, they run a higher risk of being shot at.

The main point to be learned from this report concerns analysis of survival rates based on re-sightings of neck-collared individuals. Restricting, whenever possible, the data set used in the calculations to include only females greatly improves the precision of the survival estimates. Such a restriction is favoured not only by a much higher collar retention rate in females, but also an extremely high fidelity to natal area (Nilsson & Persson unpublished). But even in such an analysis, resulting survival rates should be divided by retention rates obtained in this study, to correct for neck collar losses. At the same time, however, the number of individuals receiving a replacement collar must be taken into consideration.

The rates reported above give a measure of the extent of neck collar losses in the study population up to now, but little about future losses. There are several factors that can give rise to a completely different picture of loss rates. The most likely candidates among these are the ageing of collars, changes in hunting practise and hunting pressure, as well as changes to new types of glue and neck collars. For that reason, it is of importance that the recapture of neck-collared individuals continues by routine for as long as the marked population is a vital part of a research project.

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Sammanfattning

Halsringförluster i en population av grågås Anser anser

Syftet med denna analys var att klarlägga hur stora de årliga förlusterna av halsringar varit i en märkt grågåspopulation som häckar i sydvästra Skåne. När halsringmärkning utnyttjas för flyttningsstudier behöver man vanligtvis inte ta hänsyn till eventuella ringförluster, såvida de inte är extremt höga. Utnyttjas fåglarna däremot för att studera populationsdynamik, till exempel överlevnad, är det viktigt att skaffa sig kunskap om hur stora ringförlusterna är, samt om de varierar mellan olika segment av populationen.

Fångst av grågåsfamiljer för märkning med halsringar och konventionella metallringar har skett årligen i sydvästra Skåne sedan 1985. Inklusive en provfångst 1984 försågs totalt 1700 gässlingar och 575 fullvuxna fåglar med halsringar till och med 2000. För beräkning av halsringförluster utnyttjades endast de individer som återfångades efter att ha halsringmärkts under tidigare år, totalt 179. Med den använda fångstmetoden var sannolikheten för att en individ skulle återfångas oberoende av om fågeln fortfarande bar sin halsring eller om den förlorats. Den första generationen av halsringar som användes inom detta projekt exkluderades, eftersom de var av sämre kvalitet. Tack vare en hög observationsfrek-

vens året runt kunde den period under vilken en återfångad fågel hade tappat sin halsring begränsas till mellan 2 och 46 dagar för samtliga individer utom två. Förlusterna kunde därmed beräknas på den tid som halsringarna varit möjliga att förlora, istället för på den tid som förflutit mellan halsringmärkning och återfångst.

Den genomsnittliga årliga förlusten av halsringar var 2,9%. De årliga förlusterna var fyra gånger högre bland hanar än bland honor (5,5% respektive 1,4%), dubbelt så hög bland fåglar märkta som gässlingar jämfört med de som märkts som fullvuxna, bland såväl hanar (8.4% respektive 4,6%) som honor (1,7% respektive 0,7%), och markant högre bland fåglar som övervintrade i sydvästra Spanien än bland de som tillbringade vintern någon annanstans (framförallt i Nederländerna och norra Spanien), bland såväl hanar (9,1% respektive 2,5%) som honor (2,3% respektive 0.6%). Bland de återfångade som hade tappat sin halsring, hade två gjort det under vintern (slutet av oktober–slutet av februari), medan 14 av övriga 15 hade förlorat den under den inledande delen av häckningsfasen, perioden 1 februari–20 april.

Den genomsnittliga årliga halsringförlusten bland de skånska grågässen är en av de lägsta som överhuvudtaget har rapporterats från någon studie. Skillnader mellan olika studier kan bero på ett flertal faktorer. Till exempel på skillnader i beteende, temperament och näbbmorfologi mellan olika arter. Såväl snögäss som taigagäss angriper sina halsringar både intensivt och länge med sina näbbar, vilket varken kanadagäss eller grågäss gör. Av större vikt är dock att halsringar av ett flertal olika material och utseende har använts, samtidigt som appliceringsmetoderna har varierat. Inom det Nordiska Grågåsprojektet visade det sig till exempel att de först använda halsringarna var känsliga för UV-ljus, vilket fick till följd att gässen började tappa dem redan efter åtta månader. Användningen av dessa halsringar upphörde därför redan 1986. I Skåne har sedan dess halsringar från tre olika tillverkare använts. Tyvärr är antalet återfångade individer än så länge för litet för att möjliggöra en analys av om det föreligger skillnader mellan dessa tre ringtyper. Likaså är det för tidigt att uttala sig om förlusterna ökar med ökande ålder hos ringarna. En dylik åldringseffekt har konstaterats i ett flertal studier, men långtifrån i alla.

Den främsta anledningen till att gäss förlorar sina halsringar är uppenbarligen jakt. I den aktuella studien finns det starka indikationer på att så är fallet. De flesta halsringar som byttes på återfångade individer var skadade av hagel. Vidare kan de höga ringförlusterna bland gäss som övervintrade i sydvästra Spanien relateras till ett betydligt högre jakttryck där än i andra områden som de skånska gässen övervintrade i. Orsaken till att individer som märkts som gässlingar uppvisar högre årliga halsringförluster än de som märkts som vuxna bör sökas under perioden från det att ungarna frigör sig från föräldrarna tills dess att de etablerar sig som häckfåglar. Under denna fas av livet är gässen, framförallt hanarna, betydligt rörligare än senare i livet, utforskande potentiella häcknings-, ruggnings-, rast- och övervintringslokaler. Därmed löper de större risk att bli påskjutna. Skillnaden mellan hanar och honor däremot förklaras vanligen med en större aggressivitet bland hanar, framförallt under parbildning och revirförsvar. Det faktum att en övervägande majoritet av alla halsringförluster bland de skånska grågässen skedde under den tidiga delen av häckningssäsongen ger stöd åt denna hypotes.

Den främsta lärdomen som kan dras av denna studie gäller överlevnadsberäkningar baserade på observationer av halsringmärkta skånska grågäss. Närhelst möjligt är bör dessa beräkningar begränsas till att inkludera endast honor. Men även då bör de erhållna värdena korrigeras för de ovan redovisade ringförlusterna, med hänsyn tagen till antalet individer som försetts med nya halsringar efter att ha återfångats. De redovisade värdena ger ett mått på halsringförlusterna i den aktuella populationen fram tills nu, men väldigt lite om framtiden. Det finns flera faktorer som kan ge upphov till en helt annorlunda bild i framtiden. De troligaste kandidaterna bland dessa är åldring av halsringar, förändringar i jaktmetoder och jakttryck, samt ibruktagande av nya typer av lim och halsringar. Därför är det av största vikt att återfångandet av halsringmärkta individer kan fortgå rutinmässigt så länge som den märkta populationen utgör en del av ett pågående forskningsprojekt.